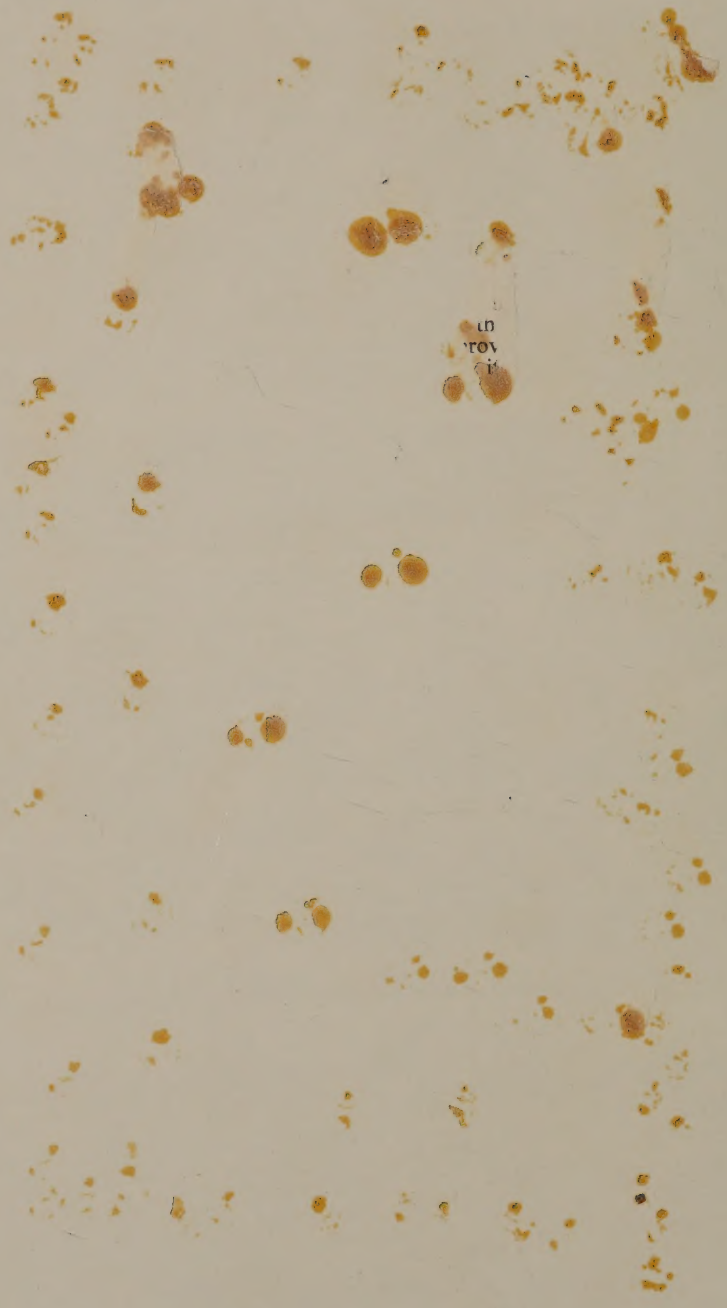
TRAFFIC IN TOWNS



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A study of the long term problems of traffic in urban areas

Reports of the Steering Group and Working Group appointed by the Minister of Transport

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Report of the Steering Group

The Steering Group

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To: The Right Honourable Ernest Marples, MP, Minister of Transport

1. We were appointed in June, 1961 to act as a Steering Group in connection with the Study of the Long Term Problems of Traffic in Towns undertaken in the Ministry of Transport. It should be made clear that the Steering Group was not intended to be responsible for the major report itself. That is the work of the Study Group in the Ministry led by Mr Colin D. Buchanan. Their Report begins on page 7, and occupies the greater part of this volume. To make the position clear, we shall refer to it as the Buchanan Report.

2. The duties of the Steering Group, as we have conceived them, have been threefold. First, throughout the period of the inquiry, we have been consulted by Mr Buchanan and his colleagues, and have been available to them for such advice as we could give. The relationship of the two Groups has been most happy throughout, and we are grateful to Mr Buchanan and the members of the Study Group for the trouble they have taken to keep us informed of the development of their work. We are also indebted to our successive Secretaries, Mr J. H. H. Baxter, Mr C. N. Tebay and Mr J. A. L. Gunn, of the Ministry of Transport.

3. Our second duty was to give the Minister our opinion of the Buchanan Report, as it emerged from the work of the Study Group. We were to be free to take issue with it either on particular matters or as a whole. In point of fact, however, we have no reserve in commending it both to the Minister and to several of his colleagues (for the problems of which it treats are by no means confined to transport) and also to the general public, by whose interest and determination these problems can alone be solved. If we have been at pains to make it clear that the Buchanan Report is not our work, this is not because we wish to evade the responsibility for it, but because we want to emphasise that the credit for it belongs to Mr Buchanan and his colleagues, not to us. We congratulate them on having produced a most imaginative and stimulating attempt to foresee the problems of the future and to prescribe remedies for them.

4. It is a pioneer study, in two senses. On the one hand, we believe it breaks a great deal of new ground. It is, we believe, the first study of the problem of traffic in towns which is both comprehensive and quantitative. It brings together two subjects which have usually been treated separately, at least for administrative purposes—namely the planning and location of buildings and the management of traffic. It attempts to put precise figures upon the flows of traffic to be expected and to estimate the capacities of the various methods suggested for dealing with it. But on the other hand the Report is also a pioneer work in the sense that it is an exploratory study indicating the direction in which thought should be turned and further researches undertaken. It is perhaps particularly necessary to emphasise that the sections of the Buchanan Report that deal with Newbury, Leeds, Norwich and part of London should not be regarded as being more than illustrations of how the principles worked out in the Report might take shape when applied to specific localities; they are not to be regarded as proposed plans for those towns and cities.

5. Our third task was to attempt to draw some of the conclusions for public policy that seem to us to emerge from the Buchanan Report. In doing this, it was thought that we, the Steering Group, could go further than might be appropriate for a Study Group working within a Government Department. It seemed to us that we could do more good by stimulating debate than by attempting to propound settled conclusions. We therefore decided not to spend many months in taking evidence, and producing another long and comprehensive report, but to set out the problem, as it seems to us, in a brief and possibly dogmatic way and to add, in the same manner, some recommendations for the solution. This we have attempted in the paragraphs that follow. We must emphasise that they are in no sense a summary of the Buchanan Report. We have found it necessary to go over some of the same ground, if only to make it clear what we are talking about. But we have attempted to do so in a way that will serve as a stimulus to reading the Buchanan Report itself, and not as a substitute for doing so.

The impending motor age

6. In Britain, the Motor Age is still at a comparatively early stage. We are approaching the crucial point when the ownership of private motor vehicles, instead of being the privilege of a minority, becomes the expectation of the majority. At present, there are in Great Britain about 16·4 million families and 6·6 million cars (excluding buses and lorries) and 1·8 million motor cycles. When allowance has been made for cars that are not privately owned, and for families that own more than one car, it is not yet true to say that more than a bare majority of families own a motor vehicle—and perhaps not quite that.

7. There is no doubt that the desire to own a car is both widespread and intense. The number of people who genuinely do not desire to possess their own private means of transport must be very small, and we think it is safe to base estimates of the future on the assumption that nearly all the families who, at any time, can afford to own a car (or who think they can) will in fact do so. The ownership of private cars is a direct function of real incomes. Not only, therefore, will the total number of cars increase as average real incomes rise, but the most rapid increase will come sooner rather than later, for the reason

that there is a very large group of family incomes now just on the verge of the car-affording class. This is reflected in the forward estimates, which are dealt with in paragraph 45 of the Buchanan Report. By the year 2010—that is, about fifty years from now—it is expected that the total number of cars will be over four times what it was in 1962, which implies an average rate of increase over the whole period of about $3\frac{1}{4}\%$ per annum compound. But the estimate for 1980 implies an average annual increase of 6% over that period of eighteen years, and in the eight years to 1970, the rate of increase will be as much as $7\frac{3}{4}\%$ per annum. Not only is there a flood of cars coming, but the greater part of the increase will be in the years immediately ahead. (See the diagram on page 27).

8. The direct consequences of this great flood of vehicles, which are the immediate concern of the present study, will be seen on the nation's highways, and most of all in the streets of our cities. But there will also be indirect consequences of a very wide-ranging character. All the industries that make and serve motor vehicles and that cater to the motorist will expand. Fuel for this flood of motor vehicles will have to be provided and (so long as it is petroleum-based) will place a burden on the balance of payments. The economic and social consequences will ramify into every corner of the national life. We doubt whether it is realised how fundamental is the influence of transport on the shape and growth of a nation's economy. When it is a question of the stimulation of underdeveloped economies in other parts of the world, it is a truism that transport is one of the two great 'nation-building' influences (education being the other) which are basic to everything else. What does not seem to be so readily accepted is that a mature economy is equally sensitive to the condition of its transport system. If the coming great flood of vehicles means freer and easier transport of goods and persons, it cannot help but be beneficial. If, however, it leads to a clogging of the arteries of transport, it may lead to a general thrombosis.

9. One particular result of the growth of car-ownership deserves to be singled out, both because it might be overlooked and also because it has a direct bearing on much that we shall have to say in the paragraphs that follow. Before very long, a majority of the electors in the country will be car-owners. What is more, it is reasonable to suppose that they will be very conscious of their interests as car-owners and will give them a high priority. It does not need any gift of prophecy to foresee that the Governments of the future will be increasingly preoccupied with the wishes of the car-owners.

10. These matters are not purely speculative. We can draw on a mass of evidence available from the United States and Canada, which are, broadly speaking, a generation further into the Motor Age than Britain. Though the total number of cars in North America is still increasing, the rate of increase relative to the population has slowed down, for the reason that these communities are much closer to the point of final saturation at which everyone who wants a car has one. The phase that we are approaching now, they went through a generation ago. And, though there are obvious differences between North America and Britain, we think they are differences of degree only and not such as to invalidate a comparison. For example, though it is true that North America, taken as a whole, has an infinity of space compared with this crowded island, there are also regions—especially the metropolitan region stretching from Massachusetts to Virginia—which are nearly as crowded as we are. It would be a great mistake to say 'Things won't be like that here'. In more respects than not, they are likely to be very much the same.

11. American experience tends to contradict one of the beliefs from which some people in this country are inclined to draw comfort—the reflection that traffic congestion will itself set a limit to car ownership. 'People won't go on buying cars when they find they can't use them'. It is important to understand the very restricted sense in which alone this seems to be true. No doubt there is some ultimate degree of congestion that would make people stop *using* their cars. But it would have to be a very far-reaching degree of congestion, far worse than anything we know at present. Lack of a garage, or other place to house a car, can sometimes be a deterrent to the ownership of cars but probably only in the very centre of large cities. There is little evidence that congestion of traffic stops people from owning cars and *trying* to use them, and that is perhaps the fact of greatest relevance. On the facts at present available, there is apparently no tendency for the average mileage per car to fall as the total number of cars increases. The rising tide of cars will not put a stop to itself until it has almost put a stop to the traffic, essential and non-essential alike.

12. We have been speaking hitherto of privately owned motor vehicles, which do indeed constitute the largest part (and an increasingly large part) of the total. But alongside the rise in their numbers, there has been an equally formidable rise in the numbers of lorries, vans and cars used for business purposes. The total of commercial vehicles has risen by 53% in the last 10 years, and it is clear that this increase also is likely to continue. However successful the railways are in recapturing long-distance goods traffic, the volume of commercial traffic in towns will hardly be affected, and it is bound to grow with the growth of the economy.

13. These increases are likely to be compounded by the rapid rise in the total population of this island which, it is now evident, faces us in the next few decades. The most recent estimate of the Registrar-General is that in 30 years' time the total population of the United Kingdom will be 25% higher than it is now. These additional millions will want to own cars, and they will give rise to an added volume of business and commercial traffic, most of which will be carried on the roads.

14. In some parts of the country there will be still another aggravation. We would not wish to prejudge the success of the efforts that are now being made to attract industry and population to those parts of the country that have been losing them. But it is doubtful whether they will have such a far-reaching success as wholly to reverse the present tendency for South East England and the Midlands to grow at a faster rate than the rest of the country. This means that, however severe the traffic problem looks like becoming in the country as a whole, it will be even more severe in those parts that are already the most congested.

15. The loss of wealth and of amenity that the nation is inflicting on itself through the congestion of traffic is already very large. There is an enormous waste of manpower. No longer, in our cities, can life be divided between work, sleep and leisure; there is a fourth division of time spent sitting in vehicles that, if they are moving at all, are moving far too slowly. There is a waste of capital. Too many vehicles have to be provided to do the necessary work of transport, and the

time required to produce almost anything is unduly prolonged. There is a waste of fuel—almost all of it imported. There is no doubt that these economic wastes add up to hundreds of millions of pounds a year.

16. Nor are these the only losses that the rising tide of motor traffic brings with it. In 1962 no less than 6,709 people, 761 of them children, lost their lives in road accidents. This is the worst wastage of all, and it also can be expected to rise with the traffic, unless effective steps can be taken. The largest proportion of the whole, and that part that should be regarded as being most preventible, is accidents to pedestrians. It may be that future generations will regard our carelessness in allowing human beings and moving vehicles to use the same streets, and our apparent callousness to the inevitable results, with the same horror and incomprehension with which we recall the indifference of earlier generations to elementary sanitation.

17. Everyone is conscious, in a general way, of 'the traffic problem' and that it is on the increase. In the course of the present study, we have had to look at the quantitative facts of the probable increase and to try to imagine, with some precision, some of the probable consequences. We are not conscious of any exaggeration in saying that we have been appalled by the magnitude of the problem and by the speed with which it is advancing upon us.

Suggested remedies

18. We pointed out in paragraph 10 that the United States and Canada are about a generation further into the Motor Age than we are. Their volumes of motor traffic, per head of the population, are already what ours will be at some time in the future. Yet, though their traffic problem is by universal consent a severe one—there is heavy economic waste through traffic congestion, and tragic waste of human life—they have not suffered the ultimate calamities that we are suggesting lie ahead for Britain. Can we not do what they have done? If one asks how American cities have at least kept pace with the growth of motor traffic, the major answer is by the construction of new roads, bridges, underpasses and the like on a truly gigantic scale. Some of these roads are magnificent engineering achievements driven through the hearts of the cities with great ingenuity—but also, all too often, with a brutal disregard for the appearance and the amenity of the cities they serve. Combined with the provision of off-street parking facilities on an equally large scale, they make it possible for a considerable proportion of the working population of nearly every American and Canadian city to drive to their work. If this solution has worked in America, would it not work here?

New urban roads

19. Beyond any question, there will have to be a great deal of urban road-building in British cities. The scale on which this will be necessary can be clearly seen from the practical studies in Chapter Three of the Buchanan Report. Moreover, if these new roads are to perform their function of carrying the very heavy volumes of traffic that will arise in the future, many of them will have to be free of such obstructions as cross-roads and roundabouts. Some of them, indeed, in the larger cities, will have to be built to motorway standards.

20. The engineering and other difficulties of building new roads in cities should not be underrated. The greatest difficulty is the land that such roads require. Only rarely will an existing street be wide enough to serve as a main distributor without some destruction of buildings. Interchanges are particularly voracious consumers of space, needing up to 40 acres or even more*, depending on the number of streams of traffic to be separated from each other. Nevertheless, these technical problems are not insoluble, given the money and the determination to solve them.

21. But there are a number of considerations that set limits on what can be hoped for from even the most vigorous policy of urban road-building. In the first place, most American cities are physically much better adapted for the creation of motorways than any British city. All but a few of the oldest are, even in their centres, much less tightly packed than the typical British city. There are more interstices through which the roads can be driven. (It is relevant to observe that in Manhattan Island, New York City, the most tightly packed American city, the only motorways that it has been found possible to construct are on the edges of the island). Moreover, most of them, when the Motor Age began, were surrounded by spacious open country, and there was scope for a policy of making room for the motorways by decanting part of the population of the city to its fringes. If a large proportion of the working population of a typical American city can drive to work every day, it is partly because many of the work places have been evacuated to the periphery. The difficulty of preserving any green countryside between our towns is already so great that there is very little scope for a similar policy in Britain.

22. Secondly, the American policy of providing motorways for commuters can succeed, even in American conditions, only if there is a disregard for all considerations other than the free flow of traffic which seems sometimes to be almost ruthless. Our British cities are not only packed with buildings, they are also packed with history, and to drive motorways through them on the American scale would inevitably destroy much that ought to be preserved.

23. Thirdly, even with all the advantages that their circumstances provide for the success of a motorway policy, many Americans are coming to doubt whether it provides a final solution. Each new motorway, built to cope with existing traffic, seems to call into existence new traffic sufficient to create a new congestion. The leading case is that of San Francisco and its satellite cities, where the citizens recently voted to tax themselves for a new system of inter-urban railways, because the motorways were becoming too congested. San Francisco, limited in its expansion on three sides by salt water, is not a typical American city. But British cities are restricted in their expansion on all four sides, and the case history may well be relevant.

24. We believe that there is need in this country for a vigorous programme of urban road-building—not rushed into haphazardly, but as the result of careful analysis of probable traffic flows and needs. But we cannot hold out any hope that this by itself will go very far towards solving the problem.

* For comparison, the area in London bounded by Piccadilly, Lower Regent Street, Pall Mall, and St. James's Street is 35 acres; Green Park is 53 acres, and St. James's Park 93 acres.

Expanded public transport

25. Another possible line of attack on congestion, to which the Americans themselves are now increasingly turning back, is the development of public transport. The car-commuter, the worker who uses his car to travel between home and work, is the heart of the urban traffic problem, which would be reduced to more manageable dimensions if he did not exist. To the extent that he cannot be prohibited from driving to work, or taxed out of it, or provided with roads to do it without producing jams, perhaps he can be persuaded to do his journey by bus or train?

26. The operative word in the foregoing sentence is 'persuaded'. The commuter cannot be forced back on to public transport—not, that is to say, in a car-owning democracy. It has to be recognised that, once a man has a car, which he may have acquired for reasons quite unconnected with his work, he may find it very attractive to use for the daily journey to work. He can go from door to door, or at least from his own door to very near his place of work. He is not dependent on time-tables. He is sitting in comfort, not standing in a crush. He can listen to the radio, or talk to a companion—or escape a bore. Other people, of course, positively prefer public transport, but the choice between them is rarely a matter of relative cost, or even of the relative time taken. To an increasing section of the community, the advantages of car-commuting outweigh the facts that it may cost more, that it may take longer, and that it may end in a tedious search for a place to park. This last is, we believe, the main limitation on the growth of car-commuters. In this connection, we would plead for a reconsideration of the present official policy of automatically insisting on the provision of garages in all new office buildings. In some cases, garages are necessary. In others, they simply encourage the growth of car-commuting where public transport was formerly used. The decision whether or not to require a garage, of what size and for what purpose, should be taken on an analysis of the traffic problem and parking needs of the area. It should not follow as a piece of automatic arithmetic from the size of the building (see paragraphs 452 to 456 of the Buchanan Report).

27. Even if it were pushed most vigorously, therefore, we do not believe that the expansion of public transport could by itself provide a complete answer. To prevent the steady rise of car-commuting, it would be necessary to provide a great many more bus and tube routes, running at very frequent intervals, at reasonable fares and with enough vehicles to guarantee a seat to every passenger. This could hardly be done on a paying basis; it is very questionable whether it could be done at all. But this is not to say that the expansion of public transport cannot make a large contribution. Regarded not as a solution in its own right, but as one arm of a co-ordinated policy, we think the case for expanded public transport in cities is proved. Without questioning, in its general application, the policy of making transport pay its way, we think the particular case of urban passenger transport needs to be considered in a wider context than the simple comparison between what can be collected in fares and what the service costs to run. Nor does this involve bringing in the inevitably vague conception of 'social requirements'. It ought to be a strictly economic calculation. In any given city there is a calculable number of bodies to be moved between home and work and back again every day. The number that can possibly be carried in private cars, even after an extensive programme of road-building, is also calculable and limited. The remainder will necessarily have to use public transport, and the means of providing it is one of the essential elements of the sort of co-ordinated and comprehensive planning that is clearly needed.

28. There should also be a much more determined attempt to provide for what may be called the 'semi-commuter', the man whose needs would be met if he could drive his car to a suburban station or bus-stop, and be sure of finding parking space there. It would surely pay, in the wider sense, to make multi-storey garages at such points available at very low prices, or even free.

Deliberate limitation

29. A third general means of relieving the pressure has also often been suggested. This is the deliberate limitation of the number of vehicles on the streets of our cities. In Soviet Russia this is achieved by what appears to be a deliberate restriction on the number of motor cars available for sale to the general public. We hope we may assume that this is excluded for Britain. But if a limitation on the *ownership* of cars is out of the question, perhaps a legal limitation on their *use* is not. There are several ways in which this could be done. There is, for example, direct prohibition of the circulation of vehicles at specified times and places. This we will call 'limitation by edict'. Or it has often been suggested that limitation could be secured by levying some form of special tax or charge on those who insist on driving their cars at times when and in places where they will contribute to excessive congestion. This we can call 'limitation by taxation'. And, finally, as a mixture of both methods, there is the limitation that can be secured by a restriction on the number of permitted parking places combined with a tight prohibition of parking anywhere else. This is 'limitation by control of parking'.

30. The general comment we want to make on all these methods of deliberate limitation of traffic is closely similar to what we have said in earlier paragraphs about the other two main suggested solutions—more roads and more public transport. Distasteful though we find the whole idea, we think that some deliberate limitation of the volume of motor traffic in our cities is quite unavoidable. The need for it simply cannot be escaped. Even when everything that it is possible to do by way of building new and better roads and expanding public transport has been done, there would still be, in the absence of deliberate limitation, more cars trying to move into, or within, the cities than could possibly be accommodated. And if this happens, then the result will be that even less traffic will move than might be carried. The greater the demand for circulating space, the less the supply.

31. Deliberate limitation, to some extent and by some means, there must be in the central districts of all our large cities and many of the smaller towns. This remedy, like the others, will have to be looked to for part of the final solution. But, as with the others, the extent of what can be accomplished by this means seems to us to be more limited than might appear at first sight. There are several reasons why this should be so. Perhaps the most decisive is that a car-owning electorate will not stand for a severe restriction. And even if a severe restriction could be got on to the statute book, it would be almost impossible to enforce. It is a difficult and dangerous thing, in a democracy, to try to prevent a substantial part of the

population from doing things that they do not regard as wrong; black markets and corruption are the invariable fruit of such attempts at prohibition. Even if this overriding objection could be removed, there would still be severe difficulty in pushing any of the particular methods of limitation very far.

32. The trouble with limitation by edict is that it can rarely be absolute, and the difficulties start with the attempt to define the exceptions. To close a single street, for a defined period, to *all* traffic is possible; it is done in play streets. But obviously this cannot be applied to the problem of cities as a whole. The object of any limitation would be to make it possible for *some* traffic to move. Exactly *what* traffic? Essential traffic, of course, would have to be permitted. But what is essential traffic? Few things are more essential than the doctor going on his rounds. But how permit this and prevent the doctor from using his car to go to a party? To set up the categories of permitted traffic by definition in a statute would be impossible. But to put the power of granting or refusing permits, case by case, into the hands of any official would be most dangerous. At the best it would be arbitrary, at the worst it would be corrupt. These are only some of the very difficult questions that would arise. We do not mean to suggest that any restriction of traffic by this means is impossible. But we do think that the limits on what can be done will be found to be narrow. It will be observed from Chapter Three Part Two of the Buchanan Report that, in a large city such as Leeds, to enable even 26% of the people who work in the centre of the city to travel by private car would require very large and expensive works, while in London the proportion is even smaller. Is it conceivable that a policy of prohibiting and licensing, unassisted by other measures, could be pursued so far that only such small proportions of the applications would be granted?

33. Limitation by taxation would raise similar difficulties if it were pushed very far. We do not wish to go into the many interesting and highly ingenious methods that have been suggested for making it expensive to the car-owner to drive his car in places where and at times when there is no room for him. They well deserve intensive study and some of them will have to be tried. The point we want to make is one that applies to all of them—that they cannot by themselves go very far towards solving the problem. This, also, follows from its sheer magnitude. If a tax, or special charge, is to limit the traffic in the degree that is required, it will have to be very heavy indeed. It would probably have to be a matter not of shillings but, in some instances, of pounds per vehicle per day. Apart from all the very great administrative difficulties of levying charges on this scale (for example, there would have to be exemptions, and the same difficulty as before in defining them), there is the fundamental objection that driving in cities would then be limited to the rich or the privileged.

34. Limitation by control of parking can also, within limits, be efficacious. But those limits, though considerably more effective than we have yet reached, are very real. This method will not work at all unless the motorist is certain that he will be prosecuted for parking anywhere but in an authorised parking place, and that requires a formidable administrative apparatus, as well as creating much bad blood. It is very difficult for parking limitations to distinguish between essential and non-essential traffic, though a very rough distinction can often be made by prohibiting the all-day parking that is the mark of the car-commuter. Moreover, this method of limitation, if it is not reinforced by others, has the defect of actually creating some traffic that would not otherwise exist, in the shape of cars cruising the streets looking for parking places, or going endlessly 'round the block' waiting to pick up a passenger. Control of parking is one of the weapons of a co-ordinated plan—indeed, it is essential that the provision of parking should be calculated in relation to the traffic capacity of the roads—but used by itself without such co-ordination it can at best achieve a very arbitrary result.

Reshaping the city

35. From this summary analysis, we draw three main conclusions. The first is that there is no one easy and complete solution to the problem posed by the growth of motor traffic. All the remedies discussed above will have to be used, in one form or another. But secondly, since each line of approach reacts immediately on the others (e.g. any deliberate limitation puts an added burden on public transport, or the building of new urban roads intensifies the parking problem in the centre) it is imperative that they should not be applied haphazard by different authorities reacting to different stimuli and following different time-tables, but in a carefully co-ordinated way after comprehensive analysis and study of the whole complex. Thirdly, and most importantly, any such organised attempt to solve the problem will necessarily involve very large-scale redevelopment of our cities and towns on a significantly different pattern. If we are to have any chance of living at peace with the motor car, we shall need a different sort of city.

36. The major contribution that the Buchanan Report makes is that it tries to show what sort of cities are needed and how to get them. It sketches the outline of a philosophy or set of principles, and it also tries to bring its philosophy down to earth by showing how it would work out in actual instances. We have no intention of attempting here more than the barest summary of these views; the reader should be referred to the Buchanan Report itself. But some indication of the salient points is necessary for the continuity of our own argument.

37. The starting point is the principle that traffic and buildings are not two separate things but two facets of the same problem. To the highway engineer, buildings may simply be structures that line, and sometimes obstruct, his roads. But in fact they are the generators of the traffic and the destinations to which it is going. If there were no buildings there would be no traffic—and conversely if there were no traffic there would be very few buildings. Similarly, those who design and locate buildings should not take it for granted that the street system will be able to serve them. The buildings which generate traffic should be integrated with the traffic arrangements in an overall concept of town planning. In so far as this cannot be secured by permissive planning—that is, by regulating the activities of the public—it should be done by positive comprehensive redevelopment. This applies, of course, primarily to the commercial and industrial areas of cities. But it is also applicable to residential areas.

38. The Buchanan Report suggests that the future pattern of cities should be conceived as a patchwork of 'environmental areas'—that is, areas from which traffic (other than that which

has business in the area) would be excluded—with the environmental areas both separated and connected by a network of 'distributor' roads used for traffic and traffic only. The analogy used is that of a large building, with its halls and corridors carrying the traffic and its individual rooms representing the environmental areas. If, at first sight, the distinction between roads for traffic only and traffic-free areas should seem rather forced, then it can be answered that the distinction between rooms and corridors is also a comparative innovation in the history of architecture. As recently as the seventeenth century, all sorts of human—and even animal—traffic flowed through the *salons* of Versailles, just as today we use Oxford Street for through traffic going to the docks, vans making local deliveries, buses carrying office workers and pedestrians out shopping, all mixed up together. The environmental areas envisaged by the Buchanan Report might be predominantly residential, commercial or industrial; or they might be (and many of them should be) mixed. But each environmental area would become, as it were, a terminus for traffic, which would not enter the area unless it had business there. We believe that, if this concept is not new, the attempt to give it precise and quantitative form in specific examples is entirely novel.

39. The central areas of the largest cities, and pre-eminently of London, present a particular problem. In smaller places, there will generally be found to be room for the environmental areas and the main distributor roads carrying the traffic to be housed side by side on the flat. In the large cities, it may be that the only chance of creating real environmental areas, while also accommodating anything more than the bare essential traffic, will be to redevelop on two or even three planes. Reference should be made to the exploratory ideas for the redevelopment of an area of Central London in Chapter Three Part Four of the Buchanan Report, in which it is envisaged that the main 'primary distributors' should be built below the present surface, the secondary distributors and parking should be provided at the present ground level, and a new environmental area, virtually free of traffic, designed on an artificial 'new ground level' some feet above the present ground.

40. It is clear that any attempt to implement these ideas would result in a gigantic programme of urban reconstruction. We see no reason to be frightened of this. The central sections of most of our cities were very largely built in a few decades of the nineteenth century, and the rebuilding necessary to implement the ideas of the Buchanan Report—which would be very much less than total reconstruction—should not be beyond the powers of a few decades of our century. Moreover, we believe there would be very considerable subsidiary advantages of such a programme. Though the impelling force behind it would be the pressing need to reorganise our cities for the coming volume of motor traffic, it should be possible in many cases to draw an extra dividend in the replacement of slums or unworthy housing. Indeed, it is possible that a vigorous programme of modernising our cities, conceived as a whole and carried on in the public eye, would touch a chord of pride in the British people and help to give them that economic and spiritual lift of which they stand in need.

Ways and means

41. If anything such as this is to happen on the necessary scale and at the necessary speed, there will have to be changes in the present administrative arrangements. These are chiefly remarkable for their complexity. Town planning is in the hands of the County Councils and the large urban authorities. There are 200 planning authorities in Great Britain, many of them with subsidiary local committees.* The policies of this large number of independent authorities are co-ordinated by the Ministry of Housing and Local Government, but the amount of detail involved is so great that this co-ordination cannot go very far. Moreover, statutory planning, from its nature, is largely permissive, and therefore negative. Its power to prevent bad development is very great; its power to suggest, and still more to initiate, good planning has proved to be limited, and is only now beginning to open up on more positive lines. Trunk roads and motorways are entirely the responsibility of the Ministry of Transport, which to a large extent uses the local authorities as its agents. All other roads (including nearly all the urban roads with which we are directly concerned) are the responsibility of the local authorities themselves, though Exchequer grants are paid for many of them. The Board of Trade controls the siting of industrial, but not of commercial, buildings.

42. There are arrangements for co-ordination between the local planning authorities, the Ministry of Transport, the Board of Trade and the Ministry of Housing and Local Government. But—again, in the nature of the case—it is largely co-ordination of the negative kind that provides opportunity for representations to be made and for the decisions of one set of authorities to be modified to meet the objections of another. For the most part, it is not the sort of co-ordination that produces a synthesis of different technical approaches or from which new initiatives can be born.

43. The disjointed nature of the present arrangements is intensified by the way in which money is made available. Redevelopment is sometimes financed entirely by local authorities; often, however, part or all of the funds are raised by private development companies. Some services are wholly financed by local authorities; but work on classified roads ranks for grant from the Ministry of Transport, who are wholly responsible for financing work on trunk roads. The Board of Trade make grants towards industrial building in certain areas. So the general pattern is that a number of separate authorities, separate Government departments and separate private interests may be involved in varying degrees in financing larger scale development. Each has its own objectives, priorities and resources. Each is subject to its own statutory limitations. And with the best will on all sides, it is still difficult to redevelop on a large scale with economy of effort and concentration of force.

44. It will be clear, even from this short description, that the present arrangements, effective though they may be for the purposes for which they were designed, do not lend themselves to the taking of prompt initiatives on a very large scale and embracing the fields, now administratively separate, of town planning, transport, housing and industry. A programme for the modernisation of Britain's cities could not be carried out by the present machinery. Realising that we are sailing into deep waters, we do not think that our task will be accomplished

* In this and the next three paragraphs we describe the arrangements in England and Wales. The arrangements in Scotland are different, in some ways better. But for our purpose they suffer from many of the same shortcomings.

unless we give some idea of the sort of administrative machinery that, in our opinion, will be needed.

45. In any effective programme of urban modernisation, such as we have been outlining, it is possible to distinguish four main stages. First, there must be a clear statement of national objectives. Regional planning cannot work in isolation. Unless there is a policy on a national basis dealing with the location of industry and population, from which would flow policies in respect of roads, ports, air facilities, etc., regional planning cannot be successful. Without such a policy it is impossible to know what populations and kinds of employment must be planned for locally, nor the rate at which development can take place, nor can there be any certainty that some uncontrolled drift of events will not reduce all local plans to futility.

46. Given such a national policy, the second stage would be to delineate the local areas or 'urban regions' within which the various problems are so interrelated as to demand overall planning. An 'urban region', in nearly every instance, would be much larger than is now embraced within a single planning authority. Even where the centre of the urban region was a single city, and not a conurbation, the urban region would have to take in the whole of the surrounding catchment area, going at least as far out as the 'traffic watershed' or limit of car-commuter travel. In a few cases only in this country there would be an overlap, representing an equal pull by two or more large centres; but on the whole the 'spheres of traffic influence' of the big cities and conurbations are clearly ascertainable. The studies of these areas, and the broad regional plans to which they would lead, would require a synthesis of transport with normal town planning considerations on the lines illustrated in the Buchanan Report. Moreover, they would have to escape from the confines of what is at present regarded as financially practicable. But though these regional plans would thus go beyond the existing statutory development plans in various ways, they would clearly be exercises of the same general nature and requiring much the same sort of study. They would be extensions of, rather than substitutes for, existing planning procedures.

47. Once such a regional plan existed for an area, the third stage would be to get more detailed plans drawn up for the redevelopment of the obsolete and congested parts, for the 'primary road network' found to be necessary and for the considerable displacement and redevelopment that would follow on the construction of the network. Then there would be the fourth stage of execution—of actually bringing about the redevelopment of the obsolete and congested areas, and of driving the roads of the primary network through. These tasks would involve multifarious and very complicated financial and legal problems of land acquisition, multiple ownership and the like.

48. As we have said, the existing machinery is not designed to carry through such a programme as this. But equally, in our view, it would be a mistake to sweep away, or supersede, all the administrative machinery that now exists, simply because the task to be performed is now seen to be larger than has hitherto been realised. For the same reason it would be foolish to dispense with the services that the private developer can render when he applies his energies and his ingenuity within the framework of an overall plan. What is needed is a new agency, endowed with sufficient authority and large enough funds to knit together what is already being done, to lift it on to a higher plane and to fill in its deficiencies. Such an agency should not, in our view, be created on a national basis. A National Development Corporation would be (or at least would seem to be) very remote from all cities but London and insensitive to their needs. If, in the attempt to remove this defect, it decentralised its operations, it might suffer from dual control.

49. In our view, therefore, the new machinery should take the form of a number of Regional Development Agencies, one for each recognisable 'urban region' (and not therefore necessarily covering the whole country). The mandate to the Regional Development Agency should be to oversee the whole programme of urban modernisation in its region, in the sense of seeing that it got done, but not to take over those parts of the whole that are already being effectively done, or that can be effectively done, by the existing authorities. For this task of oversight, the Regional Development Agency should be given far-reaching legal powers and it should be the channel through which all grants for development purposes, from whatever Ministry they originated, were directed. We envisage the Agency being appointed by a Minister (after consultations with the local authorities) and organising itself on business lines, acting through a General Manager rather than a series of committees.

50. The Regional Development Agency's task should be to act partly through other authorities, partly on its own account. In the second of the four stages that were distinguished in paragraphs 45 to 47, its functions would be very largely to co-ordinate and stimulate the work of the existing planning authorities. It would be a great mistake to try to impose a plan from above; a regional plan can be made only by putting together the plans of the existing planning authorities and then re-working them, by a co-operative process, into the wider form that is needed. The third stage—the detailed planning of redevelopment and of the primary networks of roads—also seems to us to be a job, at least in the first place, for the existing local planning authorities. Indeed, if it were taken away from them, their remaining planning functions would be stultified. But here also a skilled Development Agency, with the wider view and the persuasions of finance, could play an effective role. And when it came to the fourth stage, that of execution, we think the presumption should be reversed, and the Agency would normally do the job itself unless it was satisfied that the local authority could do it as well and as quickly—and to the same high standard of layout and design. As time went on, we would expect the Agency gradually to extend the range of its own activities, taking over more and more of the development work that local authorities now do for themselves, until only the biggest authorities, which can afford to employ the large and varied staffs needed, would want to do their own. This last point is of great importance, for if the job is to be properly done, it requires a wide spectrum of professional talents—town planners, architects, landscape architects, valuation surveyors, and several sorts of engineers—all of which are in very short supply.

51. The Regional Development Agency, as we envisage it, would be a body for which there is no precedent. The nearest approach is perhaps that of the New Town Corporations (on which we have, in part, consciously modelled it). But the Agency would go much farther, both in its geographical purview and in the range of powers we suggest for it. At one end of this range, with its powers of reviewing plans and of

making or withholding grants, it would be exercising some of the powers of the Government. But the main emphasis would not be administrative so much as executive—on actually getting things done. It would itself buy and hold land and employ contractors. At this end of its range of activities, it would be more like a gigantic property-development company.

52. We sketch this proposal only in the broadest outline to serve as a basis for further discussion. We make no claim to have worked it out in detail, and many points would be subject to modification on further examination. The only counsel on which we would insist is that, if the task is to be done at all and our cities are to be saved from strangulation, a new executive agency of some sort will have to be created. We are convinced that it cannot be done by any existing agency or by any joint body formed from existing agencies.

53. A programme of the sort we have in mind would be very costly indeed. It would be foolish to try to disguise or minimise that fact. It would have to compete against many other claimants for its place in the nation's capital budget, and it is not for us to say what priority it should enjoy. We can only point to the inevitable consequences of not pushing forward with sufficient speed. 'Cost' can be defined in two ways. One is the real burden of labour and materials that would be entailed. The other is the total sum of money that would have to be laid out. The former is, of course, the more fundamental, and in the ultimate assessment of whether or not the nation can afford the programme, it is the only one that should be considered. The 'real' cost of a programme of urban renewal, though it would be very considerable, would be much less than the total of money cost would suggest, since so much of the latter would go for the purchase of land. Of the real resources required, not very much would need to be imported. Indeed, the greater part would be the ordinary resources of the construction industries which, as the last few years have shown, are capable of considerable expansion when need be.

54. Money cost cannot, however, be entirely waved aside. Money, even if none of it is to be spent on real resources, still has to be raised by taxation or borrowing, and the problems of doing so without giving rise to inflation are by no means to be ignored. The final political decisions whether or not to proceed with a programme are apt to turn at least as much on the money cost as on the real cost. Here too, however, we can point to an alleviation. If the rising numbers of motor vehicles are going to necessitate huge expenditures, they are also going to generate huge revenues. Except for the smoking of tobacco or the drinking of alcohol, there is no way of laying out the citizen's money that has proved easier to tax than the owning and using of motor vehicles. It is possible to give a a numerical indication of the importance of this. The Study Group estimate in Chapter Three Part One of their Report that the cost of constructing the new primary distribution roads of their Newbury scheme (admittedly not the whole cost, but presumably the largest part of it) would be about £4,500,000. This, of course, would be once-for-all expenditure. It is estimated that the motor vehicles registered in the Newbury area will pay in 1963 about £770,000 in licence duty and fuel duty. By 1983 it is estimated that the vehicles then registered in the same area will be paying (assuming unchanged rates) at the rate of £1,560,000. In other words, the *additional* revenue will then be something like £790,000 a year. This calculation is admittedly very crude, and we would not wish to put any heavy weight of conclusions on it. But it does serve to show what a fund of future revenue there is available to finance a programme of urban re-development. We do not suggest that this revenue should be earmarked against the expenditure that a programme such as we envisage will entail. We content ourselves with pointing out that if the rising tide of motor vehicles requires money in vast sums to be spent, it also promises large new revenues. The money to be spent should, ideally, all be spent in the immediate future and, once spent, will in great part not need to be repeated for a long time. But the new revenues will go on indefinitely.

55. It is impossible to spend any time on the study of the future of traffic in towns, even so short a time as we have been able to give, without being at once appalled by the magnitude of the emergency that is coming upon us and inspired by the challenge it presents. There is another source of fascination. We are nourishing at immense cost a monster of great potential destructiveness. And yet we love him dearly. Regarded in its collective aspect as 'the traffic problem' the motor car is clearly a menace which can spoil our civilisation. But translated into terms of the particular vehicle that stands in our garage (or more often nowadays, is parked outside our door, or someone else's door), we regard it as one of our most treasured possessions or dearest ambitions, an immense convenience, an expander of the dimensions of life, an instrument of emancipation, a symbol of the modern age. To refuse to accept the challenge it presents would be an act of defeatism. The task it sets us is no greater, and perhaps less, than was presented to the rural England of two centuries ago by the Industrial Revolution followed by the railway. If we are to meet our challenge with a greater balance of gain over loss than our great-grandfathers met theirs, we must meet it without confusion over purpose, without timidity over means, and above all without delay.

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1*st July*, 1963

Report of the Working Group

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Introduction

Our terms of reference were 'to study the long term development of roads and traffic in urban areas and their influence on the urban environment'. We were required to look at urban areas as a whole and in a general way. We were not asked to produce proposals for any specific place, least of all for London, and certainly not to produce any kind of national road plan.

The subject proved to have many ramifications. In the event we have been led to attempt a description, in terms understandable to the non-technical reader, of a problem which must surely be one of the most extraordinary facing modern society. It arises directly out of man's own ingenuity and growing affluence—his invention of a go-anywhere self-powered machine for transport and personal locomotion, and his growing ability and inclination to invest in it. It is an extraordinary problem because nothing less is involved than a threat to the whole familiar physical form of towns.

The briefest acquaintance with the conditions that now prevail in towns makes it clear that traffic congestion has already placed in jeopardy the well-being of many of the inhabitants and the efficiency of many of the activities. The potential increase in the number of vehicles is so great that unless something is done the conditions are bound to become extremely serious within a comparatively short period of years. Either the utility of vehicles in towns will decline rapidly, or the pleasantness and safety of surroundings will deteriorate catastrophically—in all probability both will happen together.

The problems are such that small-scale road improvements designed merely to keep traffic on the move are unlikely to be of lasting benefit, being overtaken by the increase of traffic almost as soon as they are finished. Such schemes may in fact make matters worse by diverting attention and resources onto local problems, while only slightly postponing the day when large-scale measures, possibly of a quite different nature, must be initiated. Large-scale measures, however, will be extremely expensive, and will involve great physical complexities of architecture and engineering; they can only be justified on the basis of a comprehensive approach to the problems of urban transport—public as well as private, goods as well as people—in order to ensure beyond any shadow of doubt that they will discharge the roles for which they are designed. It has therefore been one of the main objects of our study to suggest the broad outline of a comprehensive approach to the problems raised by traffic in towns.

As we proceeded with our task, however, we realised we were being drawn inexorably into a much wider range of problems. Some of these were concerned with the future deployment of the population, and their gravity and complexity can scarcely be exaggerated. Where, in this small island, within the next 45 years, are we going to find accommodation for a further 20 million people, or even more? Where are they going to work, and what work will they be doing? Where will they find their recreation, and what kinds will they want? Where and how are they all going to move about? How are we going to build all the necessary accommodation—the equivalent of a new Bristol every year for forty-five years—when we

already carry the burden of a vast legacy of obsolete development from the industrial revolution? These are desperately difficult and urgent questions. They concern essentially the form and organisation of urban areas, which is now coming into perspective as the supreme social problem of the future. If anyone has ever doubted the importance of town planning he surely need do no more than contemplate the relevance of these questions to our future welfare and prosperity.

We were faced too with questions concerning the more detailed form of urban areas—the kind of surroundings that make for human contentment, the value to be set on the appearance of places, the importance of the architectural legacy and the historical record in buildings and street patterns. Changes in social habits also appeared to have a bearing on our subject—the development of new shopping customs, of shorter hours of work, and of new means of static communication.

All these were matters into which we could have allowed ourselves to be drawn. But, with only limited time and resources available, we were obliged to pick our way through them as best we could, concentrating as far as possible on our special subject but drawing attention where necessary to wider issues. We are conscious that in this process we have had to make many value judgments based perforce on our own opinions and prejudices. Of one point, however, we became more and more certain as we progressed. There could be no question of a simple 'solution' to the traffic problem. Indeed we found it desirable to avoid the term 'solution' altogether, for the traffic problem is not so much a problem waiting for a solution, as a social situation requiring to be dealt with by policies patiently applied over a period, and revised from time to time in the light of events. There is no straightforward or 'best' solution.

1 The beginning of it all. The 1888 Benz.

Chapter I: The working context

1. There is some measure of agreement about the broad nature of the urban traffic problem—jams, frustrations, parking difficulties, confusion, noise and accidents—but it is a subject which lends itself to hasty and often contradictory opinions when it comes to prescribing remedies. Some people say the motor vehicle does not have a long term future at all, and therefore there is no need to do anything. Some say the problem is insoluble, and therefore it is a waste of money to try to do anything. Others say that towns and cities as they have existed for centuries are finished, and we had better recognise the fact. Some, pointing to the United States, pin their faith to the building of 'urban motorways,' but others, also pointing to the United States, say this would be quite the wrong thing to do, and that the answer is to return to the railways. Some consider that growth in numbers will of itself 'solve' the problem, because traffic will then become so thick that users will tend to stay off the roads. Some people would ban cars from city centres, but others say more parking space is needed. Still others declare it is impossible even to gauge the problem until the motorist is obliged to pay the full economic cost of running a vehicle. People are not even consistent from hour to hour—it is notorious that a person at one moment, when driving, can be intolerant of pedestrians, but a few minutes later, as a pedestrian himself, can fulminate against motorists. Nor do people attach the same importance to various aspects of the problem. Some deplore the economic losses to industry caused by traffic delays, others see accidents as the main evil, whilst others are concerned about the damage to urban surroundings. Some of these matters arouse very strong feelings, and a considerable number of societies and pressure groups has come into existence to promote various viewpoints.

2. We found it impossible, at the start of our work, to make a quick choice out of such a welter of opinions. The more we examined the urban traffic problem the more complicated it seemed to be, and we decided we would need to review it methodically in order to establish the context in which long term policies should be sought. So this chapter recounts our search for a working context. In it we trace the development of the motor vehicle, its infiltration into the country's affairs, the nature of the present difficulties, the future of the motor vehicle vis-à-vis other forms of transport, and then we examine the broad alternative policies that seem to exist for towns and cities.

The growth of motor traffic

3. The first motor vehicle to run on the roads of Britain was a Benz three-wheeler imported from the Continent. The year was 1888. The new invention was prevented from taking root for a few years by the operation of the Locomotive Acts (known also as the Red Flag Acts because they required any mechanically-propelled road vehicle to be preceded by a man on foot carrying a red flag) which had been passed originally to protect the railways from the competition of road steam-coaches. But in 1896 the Acts were repealed, and importation and home-manufacture then began in earnest. By the outbreak of war in 1914 there were nearly 400,000 vehicles in use in Britain. Private cars, motor cycles, motor buses, taxis, coaches, and goods vehicles of many descriptions had

2 London General Omnibus Company, 'B' type omnibus, 1910.

3 A tank at Thiepval, 1916.
The tracked vehicle, first developed for military purposes, has found many applications.

4 '. . . . adaptable to a multitude of specialised purposes'.

5 The motor vehicle even proves its worth for transporting a railway locomotive—through a village street.

already been differentiated, and within two years, under the stress of war, the tracked vehicle was to prove itself on the battlefields of the Somme in the form of the tank. Thus within 30 years of its introduction the motor vehicle had shown all its paces, and the intervening 45 years up to the present time have been given over to consolidation and improvement, but without further addition to the basic range of performance. Numbers however have steadily increased, and the motor vehicle has infiltrated into the country's affairs to an extent which amounts to a social and economic revolution. (Figure 6.)

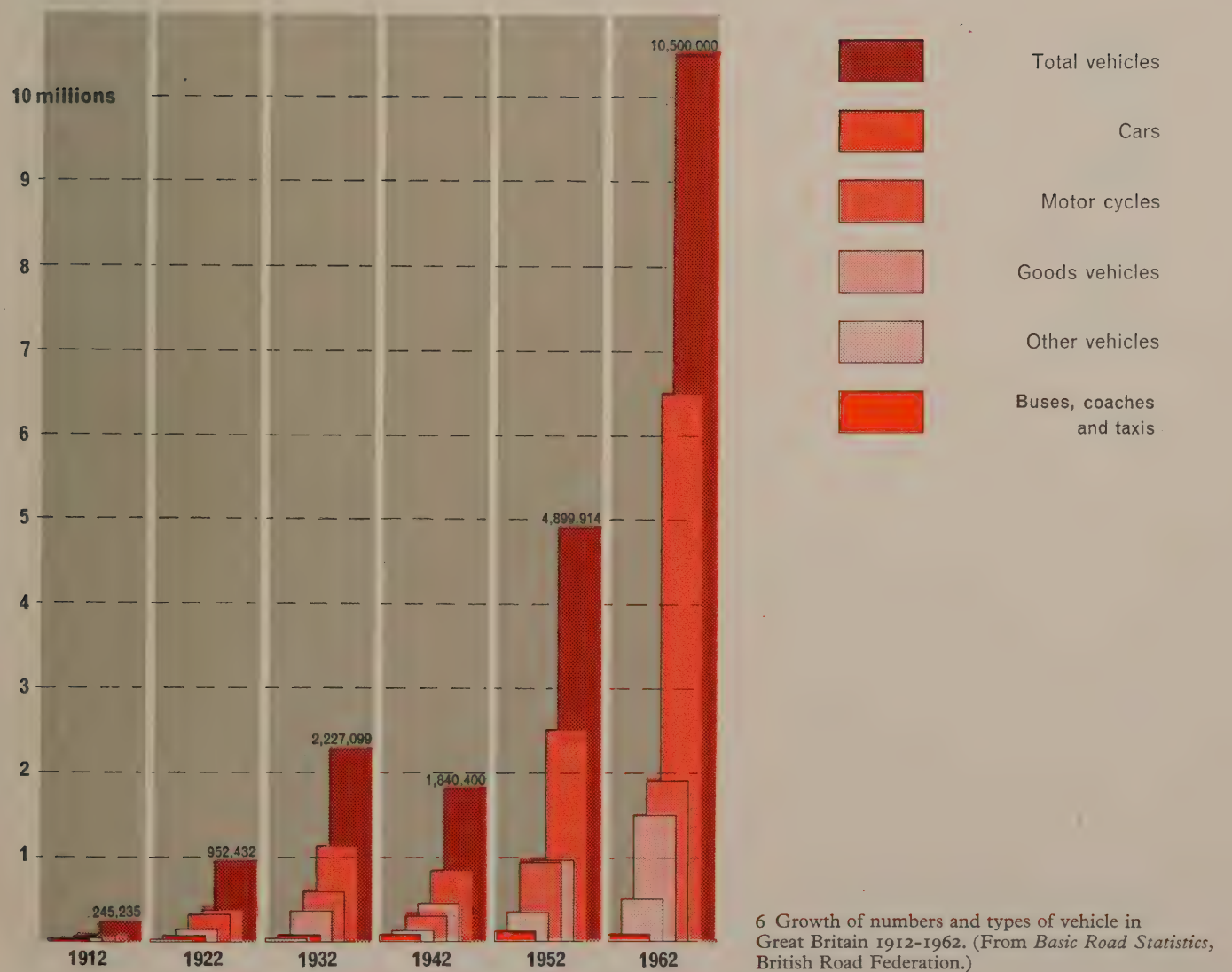
Social and economic influences

4. The social influence of the motor vehicle stems from its usefulness as a means of personal and family transport. There is still a long way to go before every adult (in the sense of a person of driving-licence age) owns his own car, and takes it as much for granted as he does his overcoat, but that is the direction in which we are moving. As long ago as 1924 Mr William Morris (as the late Lord Nuffield then was) said 'Until the worker goes to his factory by car I shall not believe that we have touched more than the fringe of the home market'. Forty years on, it still cannot be said by any means that every worker goes to the factory by car, but the massive car parks in the newer industrial areas (as in the spacious conditions of the New Towns) stand as evidence of the seemingly inexorable trend. Meanwhile, hundreds of thousands of families have already found their horizons immensely broadened and, having toured the length and breadth of their own island are now venturing far afield on the Continent. At the other extreme the motor car is making itself well-nigh indispensable for a thousand-and-one domestic purposes, from taking children to school to the Saturday morning shopping. Television-sets and washing-machines may for the time being take precedence in the hierarchy of domestic needs, but as a longer term objective it is questionable whether anything is so much desired as a family car.

5. In the sphere of public transport the motor vehicle soon started to extend its influence after the end of the First World War. One result of demobilisation was the dispersal of large numbers of men with first-hand experience of the management and maintenance of motor transport fleets. Some went in for repairs and petrol sales, starting the wide distribution of garages up and down the country upon which we are now so dependent, whilst others set up as carriers of goods or passengers. In London they started independent bus services to such effect that the virtual monopoly of the London General Omnibus Company was threatened, and in 1924 the London Traffic Act had to be brought in to give the Minister of Transport power to control the number of buses and their journeys. In the country and in the provincial towns the bus services rapidly became of major importance in the transport of the working population, and gradually the most serious and longest-standing drawback of rural life—isolation—was alleviated through their influence.

6. It was in the carriage of goods, however, that the motor vehicle exerted its greatest influence. Not only could it offer the flexible door-to-door service which the railways had never been able to provide, but it was itself adaptable to a multitude of specialised purposes. Over the years, purpose-built vehicles in bewildering variety have appeared, from trucks for the carriage of articles too large for the railways to handle, to refrigerated vans for rushing perishable goods swiftly to market. Other vehicles, not load-carriers in the strict sense, have been built as mobile providers of services, such as banks, dental clinics, libraries, mass X-ray units, and even wheeled telephone booths for conferences. There seems to be no limit to the commercial versatility of the motor vehicle.

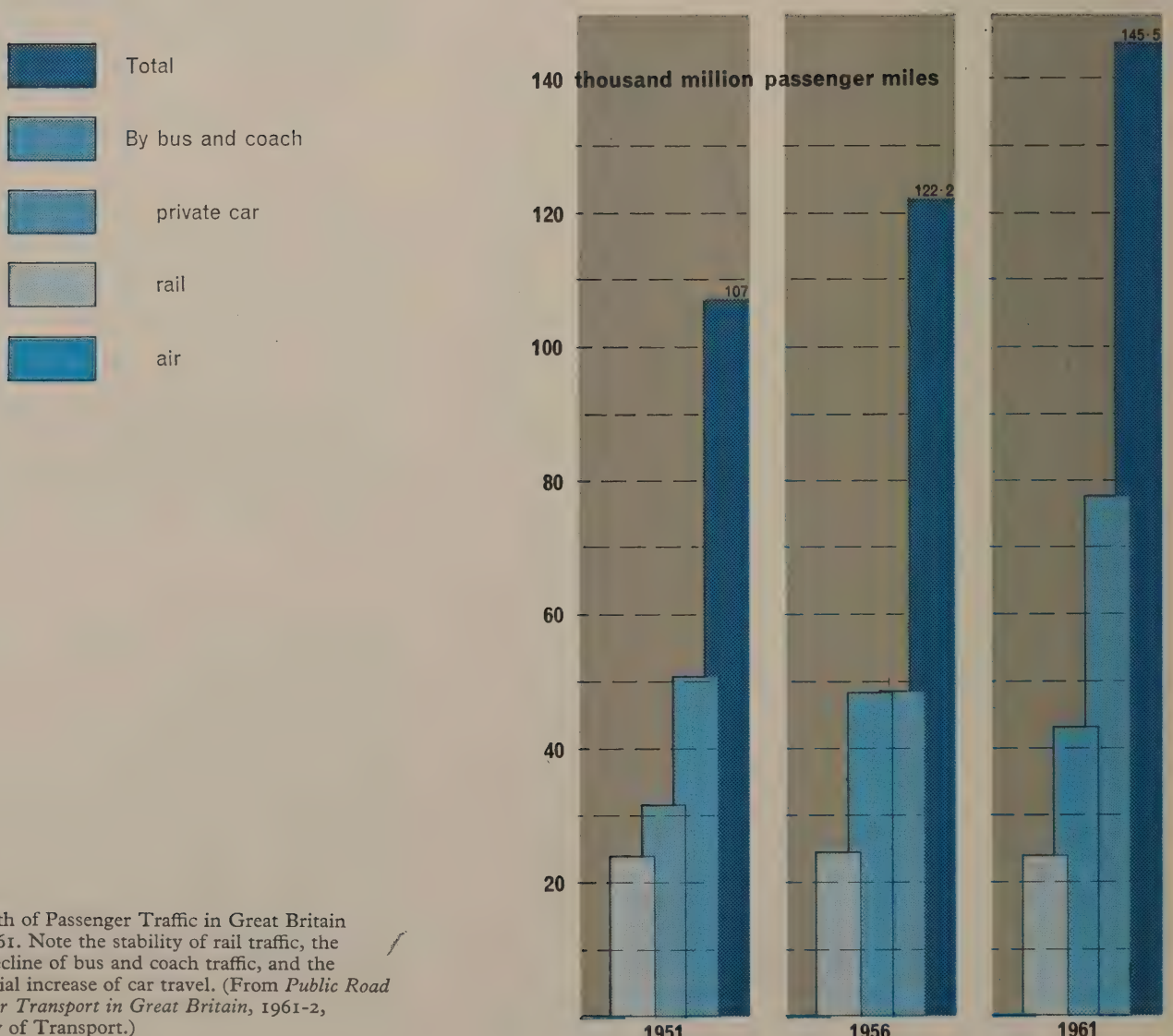
7. Thus, for personal and family use, for the movement of people in mass, and for use in business, commerce and industry, the motor vehicle has become indispensable. The early, clumsy, road steam-vehicles were easily kept at bay when they tried to challenge the supremacy of the railways, but not so the motor vehicle. Gradually it has forced the railways



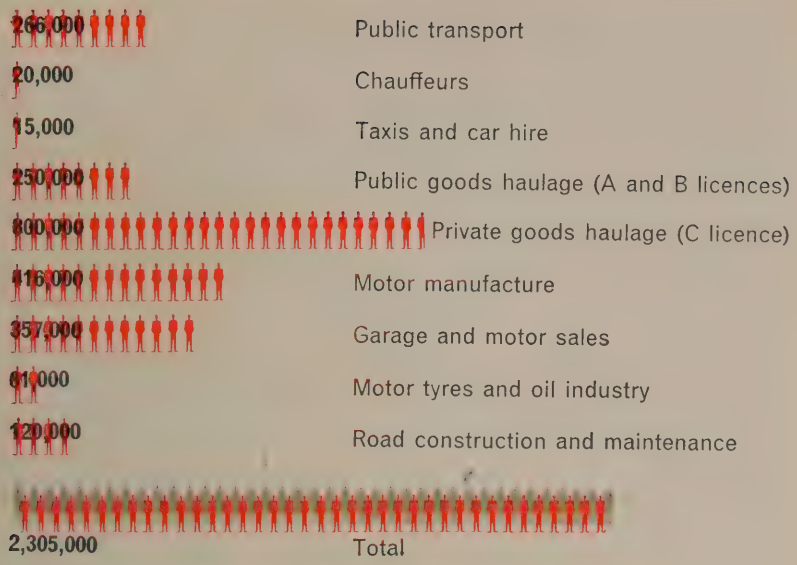
6 Growth of numbers and types of vehicle in Great Britain 1912-1962. (From *Basic Road Statistics*, British Road Federation.)

into a defensive position and now it has emerged as the dominantly senior partner in the country's transportation system. For example, in 1959, road travel represented 81% of all inland passenger travel. Of all inland goods transport (during 1958), about 72% by tonnage or 45% by mileage, was by road. (See also Figure 7.)

8. To complete the picture of the motor vehicle's importance to the nation's social and economic life, mention must also be made of all the people employed in one capacity or another in the operation of the vehicle itself, in the motor manufacturing industry, in the oil and tyre industries, and in the huge agglomeration of concerns all over the country which are engaged in selling and repairing the vehicles and marketing the oils and fuels. Figure 8 shows that 2,305,000 people are employed in connection with road transport, and Figure 9 reveals that this group is exceeded only by the employment in the distributive trades. The total employment in road transport amounts to approximately 10% of the country's total labour force. Consider also the fact that the manufacture of vehicles for export has become a main prop of the nation's economy, and it will be appreciated that as a nation we are inextricably committed to the motor vehicle.



7 Growth of Passenger Traffic in Great Britain 1951-1961. Note the stability of rail traffic, the slight decline of bus and coach traffic, and the substantial increase of car travel. (From *Public Road Passenger Transport in Great Britain*, 1961-2, Ministry of Transport.)



8 Persons employed in road transport in Great Britain in 1961.
(From *Basic Road Statistics*, British Road Federation.)

9 Employment in road transport compared with other main employment groups.
(From *Ministry of Labour Gazette*.)

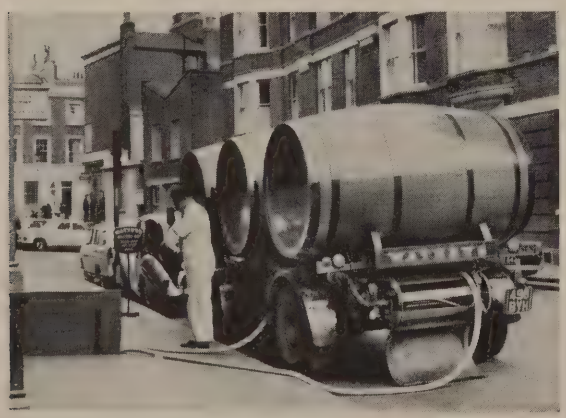
Nature of present difficulties

9. With this picture in mind of the present importance of the motor vehicle to the national life, we turned our attention more closely to the difficulties arising from its rapidly extending use. These difficulties are of two distinct kinds. On the one hand there is actual frustration of the usefulness of the motor vehicle itself (that is to say it could be even more important in our affairs than it is now), and on the other there is a range of by-products (accidents, noise, etc.) all more or less undesirable in character.

10. It can be said that there is no particular technical problem of dealing with these difficulties as they occur in open country. If the present fairly clear pattern of towns and cities set in open country is maintained, then the main traffic flows will be those between the towns, and there is an adequate understanding now of the kind of roads required to deal with them. The more intricate circulation of vehicles to farms and other open country activities can be contrived. It is mainly a matter of finding the resources for all the improvements that are required. Whether there can be dispersal throughout the countryside of week-end visitors in their millions in motor cars without ruining the countryside in the process, is another question, but it is one which lies outside the scope of this study. The point we desire to make is that, as matters stand, it is within urban settlements, where vehicles are concentrated, that the really acute difficulties are arising, and it is with these that this study is primarily concerned.

Frustration in the use of vehicles

10 Door to door service—departure.



11 Door to door service—arrival.

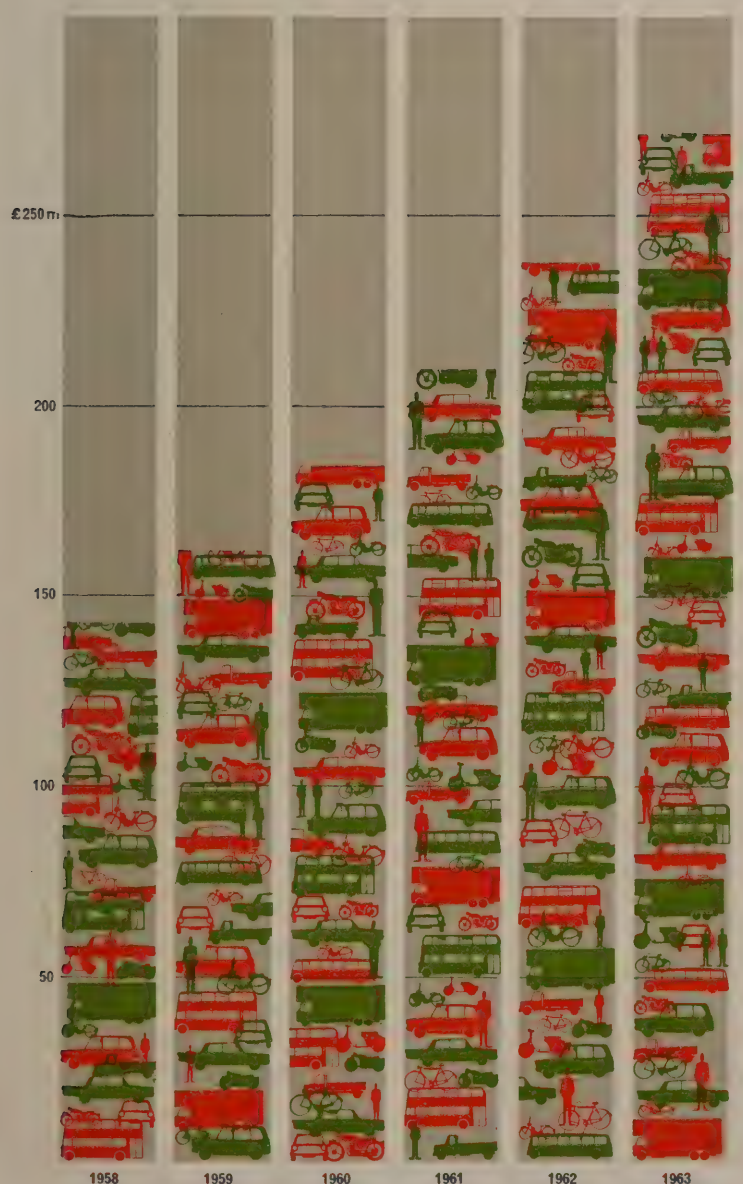
11. The characteristic which distinguishes the motor vehicle from other forms of mechanical transport is *its ability to provide a door-to-door service.* This is being frustrated partly by the multiplication of the vehicle's own numbers, and partly by the form and arrangement of towns. Only too often the doors are unapproachable, being blocked by other traffic or affected by various regulations which have had to be imposed merely to keep traffic moving. Not even doctors can now be guaranteed a space to park outside their own or their patients' houses. The loading and unloading of goods at business and commercial premises, which commands respect as essential to the continued life of the place, is increasingly being interfered with by regulations made in favour of moving traffic. The freedom with which, only a few years ago, one could stop outside a shop and go in for some simple purchase, is now a thing of the past. It is scarcely an exaggeration to say that finding somewhere legal to stop—whether it is convenient is almost a secondary consideration—has now become a major anxiety attendant upon every urban journey by motor vehicle. This is already the case in the centres of cities and many towns, and the areas so affected spread yearly with the increasing number and use of motors.

12. This is not to say that movement is not without its difficulties also. The picture is so familiar that there is little need to re-draw it nor to emphasise the frustrations and irritations of traffic jams, the waste of fuel, the waste of time, and the vast and essentially unproductive effort by police, wardens, and others engaged in many capacities in regulating traffic. Suffice it to draw attention to the fact that a conveyance has been perfected which, even in its heaviest and clumsiest form, is capable of moving at a mile a minute, yet the average speed of traffic in the large cities is of the order of 11 m.p.h.

13. A difficulty we have constantly met in preparing this report is to decide what weight to attach to the various aspects of the traffic problem. So much of it is a matter of personal opinion. We have had little opportunity ourselves to make quantitative studies, but where such work has been done we have attempted to search it out. The costs of traffic congestion, for example, have been studied by the Road Research Laboratory* and the figure for urban areas was put at £140 millions for 1958.

* See 'Economic Losses due to Traffic Congestion' by D. S. Reynolds and S. G. Wardrop in *Traffic Engineering and Control*, November, 1960.

12 Cross-country traffic—there is adequate knowledge of the kind of roads required.



13 The rising cost of traffic congestion in urban areas. (Based on calculations by D. S. Reynolds and S. G. Wardrop of the Road Research Laboratory.)

14 The conflict—pedestrians and vehicles.

15 The conflict—cyclists and vehicles (High Street, Oxford).

16 The 'Black Widow' poster of 1946, with a message so stark that it seemed to give offence, and thus lost its point.

Allowing for the increase of traffic since then, and for the fact that the cost of congestion increases faster than the growth of traffic, the comparable figure for 1963 would be over £250 millions (Figure 13). It is a difficult matter to quantify because the journeys involved are of such complexity—there are people held up in buses, for example, some of whom may be going about important business where time really is 'money', but others may be merely out for a day's window shopping. There are delays to commercial vehicles of many kinds. There are delays to commuters in their own cars, where the only real hardship may be the deprivation of an extra half hour in bed in the morning. On the other hand there are business people to whom the use of a car is a very great convenience and where delays are expensive as well as irksome. To delays so various as these it is indeed difficult to assign any meaningful cost, but it must nevertheless be generally true that an enormous amount of time and money is wasted in urban traffic delays throughout the country.

14. It should be emphasised that what is primarily involved in traffic delays is a most serious interference with the swift movement of vehicles, and hence with the economic efficiency of the country.

Accidents

15. The multiplication and increasing usage of vehicles has, unhappily, led to a great many accidents. The cause of accidents has been the subject of much dispute, and some of the reasons advanced bear the imprint of sectional interests. In theory it would seem beyond dispute that if *all* road users would take conditions as they find them, and exercise unremitting care *all* the time, there would be no accidents other than those caused by an act of God or some unpredictable mechanical failure. Human beings being what they are, however, errors and miscalculations creep in, and though these are small in comparison with the total amount of movement that takes place they are nevertheless sufficient to add up to a formidable total.

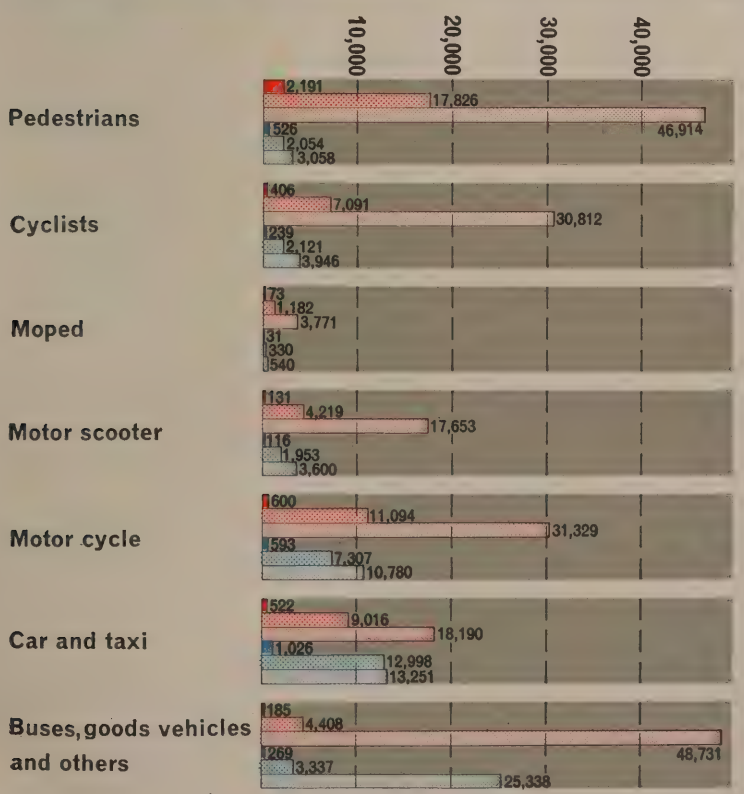
16. The number of accidents is not directly proportional to the total number of vehicles in circulation, for it is a fact that in 1934 (the peak year for accidents before the War) there were 238,946 casualties with only 2,405,392 vehicles in use, whereas in 1960 the corresponding figure was 347,551 casualties with some 9,383,140 vehicles. Thus a fourfold increase in the number of vehicles has led only to a 45% increase in casualties. There are many reasons to account for this, including improved techniques for the control of intersections, elimination of 'blackspots,' better vehicle design, and the gradual improvement of standards of road usage. Nevertheless there is a depressing consistency about the figures—month by month, holiday period by holiday period, year by year—which seems to indicate that from a given number of potentially conflicting traffic movements a predictable number of accidents will take place. The lesson seems to be—assuming no readiness by the public to *revolutionise* its highway behaviour—that a radical improvement of the situation will come only from sweeping physical changes designed to reduce the sheer number of opportunities for conflict.

17. It is understandable that accidents should be particularly numerous in the crowded conditions of towns, and 73% of all casualties take place in urban areas (as defined by the existence of a 30 m.p.h. speed limit) (Figure 19). Motor vehicles of one kind or another are of course involved in most of these accidents. There is, however, a difference of incidence inasmuch as the proportion of *fatal* accidents is greater in open areas than in built-up areas—presumably due to the higher speed at which accidents take place. Figure 10 shows the extent of the unhappy conflict, particularly in urban areas, between vehicles on the one hand and pedestrians and cyclists on the other.

18. It is sometimes represented that traffic accidents as a social evil do not bear comparison with deaths and injuries due to fire, accidents in the home and industry, or even to natural causes such as cancer. In

17 The vulnerability of pedestrians. The father pushing the pram was killed, the baby injured.

18 Urban areas claim 73% of all casualties.

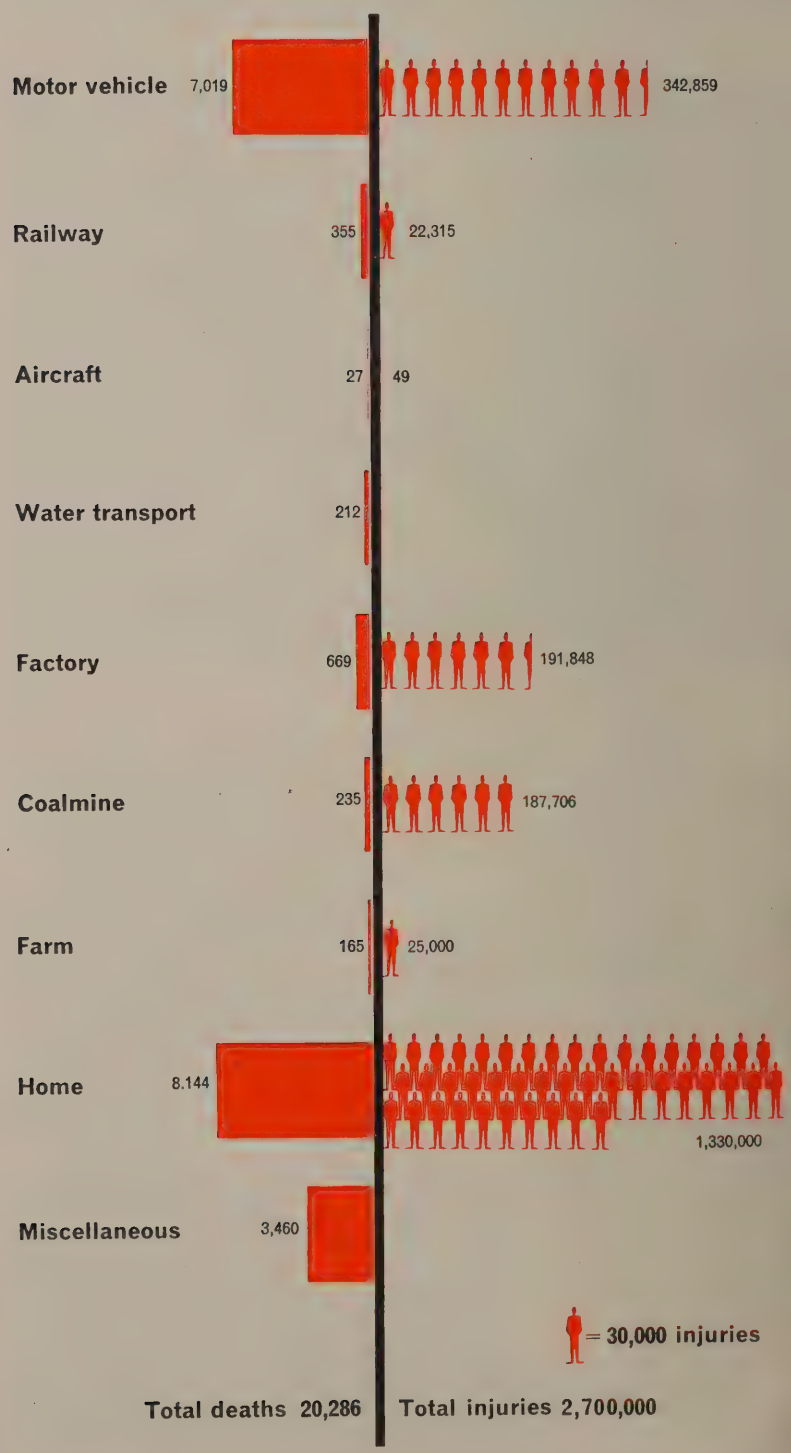


19 The distribution of casualties between the various classes of road user and between built-up and open areas. (From *Road Accidents* 1961, Ministry of Transport.)

Figure 20 an analysis is given of all the accidental deaths and injuries in Great Britain for 1961, from which it can be seen that accidents account for nearly one third of all fatalities. It must be concluded that they are a very great social evil indeed.

19. In addition to accidents involving death and personal injury, there is also a vast number of lesser accidents resulting in damage to vehicles. These are particularly numerous in urban areas where the least misjudgment when driving or parking can result in a crumpled wing or scraped panel. All these accidents set other processes in train—in repair garages, spare-parts depots, and insurance offices. In its wider context this effort surely ranks as gigantically unproductive and wasteful.

20. The cost to the community of road accidents has been the subject of several inquiries. The pioneer study was made by Professor J. H. Jones of Leeds University in 1946 when he estimated that the average annual cost for the years 1935–38 was £60,000,000. The Royal Society for the



20 Accidental deaths and injuries in Great Britain, 1961. (From *Annual Estimate* of the Royal Society for the Prevention of Accidents, and *Survey of Accidents to Aircraft*, Ministry of Aviation. Figures for injury are essentially estimates).

Prevention of Accidents, using Professor Jones' method, has estimated that in 1961 the cost of compensation for personal injury amounted to £190 millions, damage to and repair of property £19 millions, administrative costs £21 millions, giving a total cost of £230 millions.* No breakdown of these figures between urban and rural areas is available, but, as previously mentioned, a rough guide is provided by the fact that 73% of all casualties occurred in built-up areas.

21. It is interesting, finally, to compare the figures for the number of persons killed in motor vehicle accidents in Britain (1961) with those in other countries:

France: 8,700,000 vehicles; 9,337 fatalities; one fatality for every 935 vehicles.

W. Germany: 6,100,000 vehicles; 14,160 fatalities; one fatality for every 430 vehicles.

Italy: 3,000,000 vehicles; 8,000 fatalities; one fatality for every 375 vehicles.

U.S.A.: 76,000,000 vehicles; 38,000 fatalities; one fatality for every 2,000 vehicles.

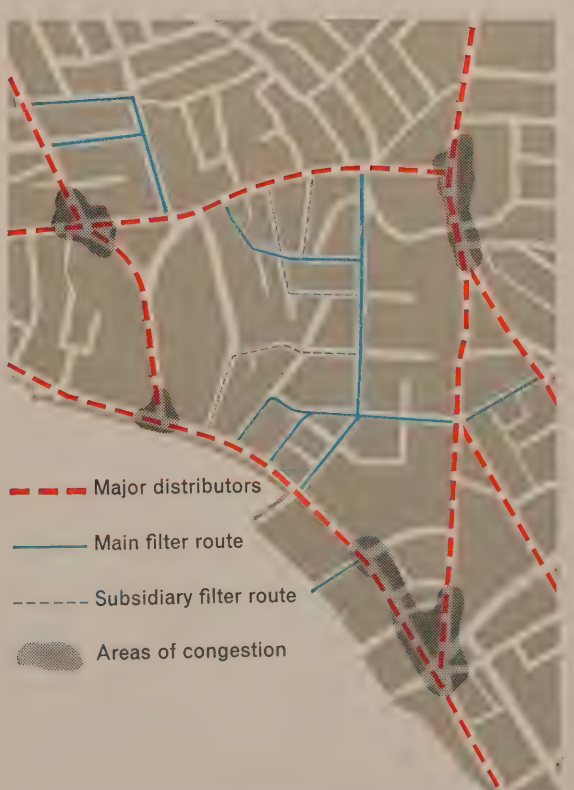
The corresponding figures for *Britain* were:
9,906,000 vehicles; 7,019 fatalities; one fatality for every 1,410 vehicles. This is slender evidence on which to generalise, but the ratio for the United States suggests that, in some way, matters are better contrived than in Europe.

21 Journey to school. In 1962, 4,287 child pedestrians between the ages of 5 and 9 years were killed or seriously injured.

Deterioration of environment

22. Whilst delays in traffic jams, and difficulties of parking have already caught public attention, and whilst road accidents have become the subject of a steadily mounting campaign to try to catch public attention, the deterioration of our urban surroundings under the growing weight of traffic has passed almost unnoticed. Part of the explanation is doubtless the fact that we have all grown up with the motor vehicle, and it has grown up with us, so we tend to take it and its less desirable effects very much for granted.

23. *Safety.* Of all the influences which the motor vehicle has on the environment the question of safety should be put foremost. It is not really possible to separate this from the matter of accidents, which has already been discussed. To be *safe*, to feel safe at all times, to have no serious anxiety that husbands, wives or children will be involved in a traffic accident, are surely pre-requisites for civilised life. Against this standard, subjective though it may be, the conditions in our towns resulting from the use of motor vehicles obviously leave a great deal to be desired. There are now virtually no urban streets that are completely safe. Even ten years ago there were residential streets where few people owned cars, and where the only traffic was the occasional coal lorry or furniture van, but now most domestic deliveries are made by motor vehicles, and many of the residents have cars. These changes have resulted in continuous movement of vehicles up and down the street; and where, as is so often the case, there are no private garages, the cars stand in the street and create additional hazards for children. Moreover, as main roads have become congested with traffic, drivers have sought alternative routes, only too often using streets unsuitable for the purpose, or invading areas which by any standard should have a measure of peace and quiet about them. Some of this infiltration has taken place by drivers on their own initiative, in other cases it is the result of official policies for expediting the movement of traffic (Figure 22).



22 Diagram of an actual case to show how drivers are seeking alternative routes, mainly through residential areas, in order to avoid congested areas on main routes.

24. *Noise.* In addition to danger and anxiety, the motor vehicle is responsible for a great deal of noise. This is a matter which has recently been under consideration, along with other aspects of noise, by an official

* See *Basic Road Statistics*, published by the British Road Federation 1962.

committee set up by the Minister for Science.* In their Report, the Committee concluded that 'in London (and no doubt this applies to other large towns as well) road traffic is, at the present time, the predominant source of annoyance, and no other single noise is of comparable importance'. The Committee distinguished five main kinds of noise from vehicles: propulsion noises (from engines, gears, transmissions and exhausts), horns, brake-squeal, door slamming, and loose loads or bodies. They discerned three possible lines of attack on the nuisance of traffic noise:

(i) *Reducing the noise emitted by vehicles*
The Committee concluded that, while there was clear evidence that amongst certain classes of vehicle the noise levels were higher than they need be having regard to the knowledge available to manufacturers, there were nevertheless considerable difficulties in reducing the noise levels from the most frequent offenders—namely diesel-engined buses and heavy commercial vehicles.

(ii) *Smoothing the traffic flow*
Vehicles produce their maximum noise when accelerating in low gear. Therefore anything that can be done to keep traffic moving smoothly will tend to reduce noise.

(iii) *Reducing traffic flows past any given spot*
This would be done by diversionary roads and other measures of a town planning nature.

25. The Committee considered that the better sound insulation of buildings against external noise could be achieved only at the expense of modern methods of building, such as light cladding, and they concluded therefore that it would be unwise to look to better insulation for any great contribution towards the mitigation of the problem of external noise.

26. We accept the Committee's general conclusion that traffic noise is now the predominant noise nuisance in towns. We certainly agree that buses and heavy commercial vehicles are the main source of noise, though it is disappointing to learn that there is no great hope of improvement in these cases. To the five main sources of vehicle noise, we would add the noise of tyres on road surfaces, especially wet or rough surfaces. Where we are in difficulty is in deciding how serious a nuisance is constituted by traffic noise. The Committee found little evidence to show that noise causes direct physical ill-effects on people, or mental or nervous illness, but they concluded that one of the commonest and most undesirable effects is the interference with communication based on sound (e.g., conversation, teaching). Our own conclusion, based on observation and many discussions, is that traffic noise is steadily developing into a major nuisance, seriously prejudicial to the general enjoyment of towns, destructive of the amenities of dwellings on a wide scale, and interfering in no small degree with efficiency in offices and other business premises. But again, this is something which people have mostly grown up with and so tend to take very much for granted.

27. The conclusions of the Committee that not a great deal can be expected towards the abatement of traffic noise either from the improved design of heavy vehicles, or from the better insulation of buildings, are extremely important. They suggest that the long term remedy must lie with town planning, encompassing at one extreme the diversion of heavy traffic flows from areas where people live, to the detailed layout of buildings and building groups at the other. This we have had very much in mind throughout the preparation of our Report.

28. Even so we are convinced, from our own observation, that much noise is caused by thoughtless and careless behaviour, and could be avoided forthwith. We have in mind the slamming of doors at night, unnecessary 'revving' of engines, all the excessive noise of motor cycles

* *Report of the Committee on the Problem of Noise*. Cmnd. 2056, H.M.S.O. 1963.

and sports cars, and (most important in our view) the rattling and banging of empty lorries, or trucks with insecure loads or loose chains or couplings. At every turn in our consideration of traffic problems, we have been impressed by the need for vehicle users to be aware of their responsibilities to the rest of the community.

29. *Fumes and smell.* These constitute a further unpleasant by-product of the motor vehicle. Fumes are emitted mainly from engine exhausts, but also from ventilation holes in carburettors and tanks, and from 'breathers' in crankcases. They contain, amongst other substances, carbon monoxide (especially from petrol as opposed to diesel fuel), unburnt elements of fuel, and carbon dust. Carbon monoxide is toxic, and carbon dust can act as a carrier for carcinogenic (cancer producing) compounds. In conditions of sunlight, fumes can develop as eye and throat irritants.

30. In Britain, engine fumes do not yet rank as a major cause of atmospheric pollution, though they are certainly already contributive to smog. But it is scarcely open to question that fumes are now rendering urban streets extremely unpleasant, though once again, since it is a situation that most of us have grown up with, it needs a conscious effort to comprehend what has happened. This nuisance is now all-pervasive through towns, no street that carries traffic is free from it. It seems to be a widely held view that fumes gather only in canyon-like streets, but a walk across any of London's river bridges demonstrates the fallacy of this. Nor is there any freedom from fumes even for drivers and passengers inside vehicles, for they breathe air sucked in at 'fume level'. This is in contrast to noise, for it is a characteristic of most modern forms of transport that the passengers are largely unaware of the noise their conveyance is making, even though the din to outsiders may be unbearable.

31. In California, motor vehicle exhaust is now the major source of atmospheric pollution (admittedly in a district where coal fires are unknown), and it is not unusual for weather forecasts to predict the degree of eye irritation likely to prevail (admittedly, again, in a sunny climate). If allowance is made for the differences between California and this country, it is clear that pollution from engine fumes is bound to increase here as vehicle numbers mount, and may even become relatively greater if vehicles spend long periods in traffic jams, with idling engines. Fortunately this appears to be a field in which technical advance is possible. In California, for example, it is already compulsory, in all new petrol-engined vehicles, for crankcase fumes to be fed back into the cylinders for combustion; and legislation exists to require the fitting of devices for burning off exhaust fumes, but it does not appear possible to enforce the requirement, as yet, for want of a proven device at a reasonable cost. However, research is proceeding, as it is in this country, and it is possible that a rapid advance could take place if public opinion were alerted to the present nuisance.

23 '. . . the crowding out of every available square yard of space with vehicles . . .' (Ely Place, London).

24 Encroachment. In this example cars have been allowed to take complete possession of the footpaths.

25 '. . . buildings seem to rise from a plinth of cars' (Place Vendôme, Paris).

26 '. . . the paraphernalia deemed necessary to help traffic flow'.

27 '. . . the odd corners and minor spaces round new buildings . . .'.

32. *Other environmental difficulties.* The motor vehicle has been responsible for much else that adversely affects our physical surroundings. There is its direct competition for space with environmental requirements, at its greatest in city centres where space is limited and traffic at its most dense. In very few towns is the record other than one of steady encroachment by the motor vehicle, often in small instalments, but cumulative in effect. There are the visual consequences of this intrusion of motor vehicles, the crowding out of every available square yard of space with vehicles, either moving or stationary, so that buildings seem to rise from a plinth of cars; the destruction of architectural and historical scenes; the intrusion into parks and squares; the garaging, servicing and maintenance of cars in residential streets which creates hazards for children, trapping the garbage and the litter and greatly hindering snow clearance; and the indirect effect of oilstains which render dark black the only suitable colour for surfaces, and which quickly foul all the odd corners and minor spaces round new buildings as motor cycles and scooters take possession. There is the other kind of visual effect resulting from the equipment and works associated with the use of motor vehicles: the clutter of signs, signals, bollards, railings, and the rest of the paraphernalia which are deemed necessary to help traffic flow; the dreary, formless car parks, often absorbing large areas of towns, whose construction has involved the sacrifice of the closely-knit development which has contributed so much to the character of the inner areas of our towns; the severing effects of heavy traffic flows; and the modern highway works whose great widths are violently out of scale with the more modest dimensions of the towns through which they pass.

How serious are these effects?

33. We have briefly described the adverse consequences of motor traffic in towns, giving such figures as are available to illustrate their seriousness. But even so, when a comparison is made with other problems of the day, it is very much a matter of judgement. Accidents, as we have already concluded, obviously must be taken very seriously. There is no need to elaborate this point further. But how serious is it that elderly people should be frightened of crossing the road, or should feel confused or even dazed by the close passage of heavy vehicles? What weight should be attached to the anxieties of parents when their children are out on the road? Does it really matter that conversation on pavements, and even inside buildings, should be virtually impossible in many places on account of traffic noise? If it proves to be the case that there is a connection between exhaust fumes and lung cancer then this will be a serious matter, but apart from this are fumes really a nuisance? And when it comes to the visual intrusion of the motor vehicle is there any evidence that this worries more than a very few people? The London Squares, which were originally conceived as the setting for the surrounding buildings, are full of parked cars and many serve also as part of major traffic routes; little

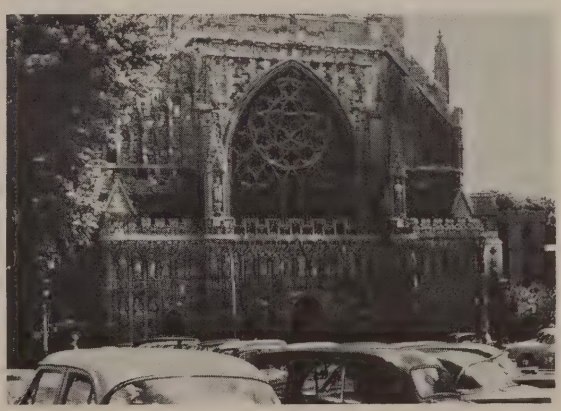
architectural gems such as Queen Anne's Gate, or (to move abroad) the Place Vendôme in Paris, are packed with cars every weekday; there is little hesitation in using cathedral closes for parking, and any revenues are gladly received by the ecclesiastical authorities; in the United States, where so much has been done to create beautifully landscaped residential areas, the cars stand out all over the place and are accepted as part of the scene, and the disused garages are converted to stores or playrooms. Is it realistic in these circumstances to be concerned about visual intrusion at all?

34. These are very difficult, subjective questions, yet they are vitally important because the answers given to them will determine the character of the traffic problems, and hence the nature of the policies to be applied. The standpoint we take in this appreciation is a simple one. It is that no person confronted with the issues, from accidents to visual intrusion, and burdened with the responsibility of deciding upon them, could do other than conclude that they are indeed very serious matters. To take any other view would be to put oneself out of line with a whole section of social endeavour directed over many years to the raising of environmental standards, and the promotion of understanding and enjoyment of the visual arts, architecture and landscape design.

35. Out of all the matters mentioned, the question of visual intrusion is the most debatable. It is sometimes said that the motor vehicle 'is part of modern life and must be frankly accepted as such'. The counter-argument is that indifference to visual intrusion leads eventually to a slovenly disregard for the quality of surroundings. Permanent parking at the kerbside, for example, becomes accepted, then maintenance and running repairs are accepted, derelict cars are allowed to stay, the street garbage and litter are accepted for they cannot be swept away, the oil stains and grease are accepted. The open parking lot is accepted and with it the damaged kerbs, broken railings and battered signs that hard usage invariably leads to. And so it goes on. With it all, it can be argued, comes increasing disrespect for the whole architectural and historic heritage. There is nothing it can be held, in the experience of the United States, to suggest that frank acceptance of the visual impact of the motor vehicle is leading to the emergence of any new kind of brilliant, lively urban townscape. On the contrary it is producing unrelieved ugliness on a great scale. Once again we have to take a standpoint in this study, and our conclusion is that visual intrusion is a serious matter to which society, perhaps after some false starts and bitter experience, will be bound to pay serious heed. This conclusion may not easily be accepted or even understood in terms of today's traffic loads and their impact on existing surroundings. But we are concerned with the future when, unless positive policies are adopted and implemented, the number of vehicles will be so great as to dominate the visual scene entirely.

28 '. . . dreary, formless car parks . . .'.

29 '. . . highway works violently out of scale with the more modest dimensions of the towns through which they pass'.



30 '. . . little hesitation in using cathedral closes for parking' (Exeter).

31 '. . . Derelict cars are allowed to stay'.

32 '. . . Indifference to visual intrusion leads eventually to a slovenly disregard for the quality of surroundings'.

The future of the motor vehicle

36. The picture we have drawn so far shows a high degree of dependence upon the motor vehicle for transportation purposes, yet in many ways the arrangements for its use are grossly inefficient, self defeating of the motor vehicle's own peculiar properties, and productive of side effects which add up to a major social problem. In the circumstances it is justifiable to examine the motor vehicle itself as a means of transport, and to enquire whether it really does seem to have a long term future before it. This obviously involves some speculation, but it would be foolish to embark upon drastic and expensive alterations to towns to accommodate motor traffic if there were any serious doubt as to its continuance as a means of transport.

37. The motor vehicle of course cannot simply be 'disinvented'. Events have passed far beyond the point at which it would have been possible to revert to railways, though doubtless some loads could even now be transferred with advantage from road to rail. The fact is that a vast amount of development has been disposed around the country—including great suburban estates round the cities—based on the motor vehicle as the form of transport, and life in these areas could not continue to thrive except with a substitute offering the same range of services as the motor.

33 Personal jet propulsion.

34 The experimental monorail track of S.A.F.E.G.E. TRANSPORT near Paris. The car is suspended from rubber tyred bogies running inside the duct, and operation is thus silent and impervious to weather.

Individual air travel

38. The possibility most usually canvassed is that within a measurable time some kind of individual jet-propulsion unit will be developed, of which a rudimentary form has already been tried out in the U.S.A. for military use. This may well come about, but the problems of weather, navigation, air-space, and traffic control appear so formidable that it may be questioned whether such a device would ever be practical for mass use, for either freight or passengers, in the crowded conditions of the modern city. One only has to think of the rush-hour conditions in any large city to realise what would be involved. Another factor, it may be hoped, will exercise a strong restrictive influence on a technical development of this kind, namely the preservation of privacy. The motor vehicle has been eroding many of the common amenities of life, but there is still some privacy left in back gardens, verandahs, bedrooms and on roof-tops. All these would be threatened if people could take off vertically at will, proceed in any direction, and hover about just as they pleased. Strict canalisation of movement would almost certainly be demanded, and if this resolved itself into the equivalent of roads up in the air then the advantages of this kind of transport might not be as overwhelming as they appear at first glance. This is not to say however that vertical-take-off aircraft may not be developed considerably as freight cars and multi-passenger units, but in this case they would not be providing the individual, highly flexible, door-to-door service which, unquestionably, is the feature of the motor vehicle that gives it its greatest appeal. The competition would tend to be with existing methods of public transport, particularly long-distance transport, and the result might well be to leave motor transport in towns more or less unaffected.

Other possibilities

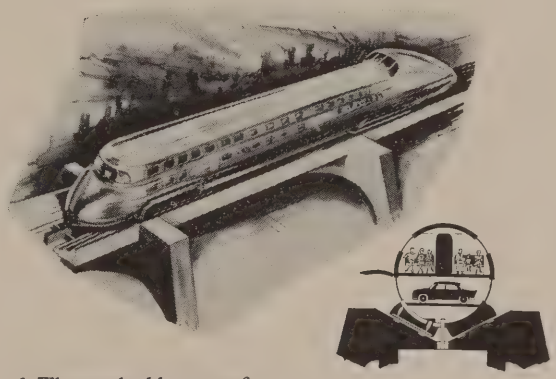
39. The same argument would probably apply to the development of other means of transport such as monorails (which offer the great virtue of silence), and tracked hovercraft (which offer the possibility of very high speeds). In both cases the competition would tend to be with existing forms of longer-distance public passenger transport, particularly the railways, rather than with motor transport in towns. A development which may offer a more direct challenge to the motor car, assuming the problem of noise can be overcome, is the air-cushion craft. It seems to give scope for development as a small personal machine, useable perhaps eventually on ordinary pavements as a substitute for walking. Yet it may be questioned whether it would really take this form, whether the urge to put a perspex cover over it for weather protection, to use it at higher speeds, to add

35 A vast amount of development disposed on the basis of the motor vehicle as the form of transport.

extra seats, and to affix luggage containers, would not soon convert it into a motor car in all respects but the possession of wheels.

The need for study of transport methods

40. It is possible, of course, if serious technological studies were undertaken, that a whole range of new ideas for moving people and goods in cities would be produced. It is indeed to be hoped that we are not at the end of our ingenuity in the matter. The bus, for example, for all its convenience, does not appear to be the last word in comfort. The travalator seems to offer much scope for development. Continuously operating chair-lifts might be used in a highly attractive way between points of pedestrian concentration to augment existing means of travel. Conveyor belts, pneumatic tubes, and pipelines might well be developed for the conveyance of goods, perhaps even justifying rearrangement of commercial processes to facilitate their use. Why, for example, should the streets have to carry large tankers delivering fuel oil to individual buildings, when it could be piped in the same manner as water or gas or (as in New York) steam?*



36 The tracked hovercraft.

Advantages of a ground-based individual machine

41. Even so, it is difficult to see any new method of movement coming along which will be seriously competitive on a big scale with the motor vehicle. There are so many advantages in a fairly small, independent, self-powered and highly manoeuvreable means of getting about at ground level, for both people and goods, that it is unlikely we shall ever wish to abandon it. It may have a different source of motive power so that it is no longer strictly a motor vehicle, it may be quieter and without fumes, it may be styled in some quite different way, it may be produced in smaller forms, it may be guided and controlled in certain streets by electronic means, it may have the ability to perform sideways movement, but for practical purposes it will present most of the problems that are presented by the motor vehicle of today.

37 The air-cushion craft.

42. Our conclusion, therefore, is that the future of the motor vehicle, or of some equivalent machine, is assured. We think it follows that a close, constructive examination must be made of towns and cities in order to see how the best use of the motor vehicle can be achieved in those places, and how the present difficulties can be overcome. This represents the basic standpoint of our study. We accept the motor vehicle as a potentially highly beneficial invention. It is implicit in this that we reject, as an initial standpoint, a currently held view that the traffic problem in towns would take on an altogether different complexion—that it might indeed almost disappear—if motorists were obliged to pay the full economic costs of running their vehicles, including the rental of road space. We think the public can justifiably demand to be fully informed about the possibilities of adapting towns to motor traffic before there is any question of applying restrictive measures.

* Developments of this kind would be assisted if the archaic practice of burying pipes and cables in the ground underneath the road surface were abandoned, as urban reconstruction proceeds, in favour of capacious service ducts constructed integrally within the road. The idea is illustrated in the study for a central metropolitan block in Chapter III (Part Four).

The future growth of traffic

43. If the future of the motor vehicle is assured, and if we are to examine towns in a constructive way to see how traffic can be accommodated, then three questions become very important in the assessment of the long term problem: How many vehicles are there likely to be? At what rate will the numbers increase? And how much will the vehicles be used? Once again these are complex questions to which there are no straightforward answers.

Increase in the numbers of vehicles

44. The growth in the number of *private cars* would seem to depend primarily upon the growth of incomes, but it is also dependent upon the price of cars, insurance rates, taxation levels, and upon such factors as changes in shopping habits, the availability of garage space, the amount of frustration due to congestion, the existence of other cheap and convenient forms of transport, and the future patterns of recreation. It will also depend on the growing familiarity with and acceptance of the advantages of having a motor car. The increase in the number of *goods and commercial vehicles* will depend upon the usefulness of this form of transport to the firms involved, and to the coming into existence of new firms, new processes, and new or expanding markets. The future number of *public transport vehicles* depends largely upon the extent to which the public does or does not switch its travelling habits to private cars. Underlying both the growth in numbers and the usage of vehicles is a problem which has not previously been given any prominence but which yearly assumes greater importance, namely the sheer capacity of urban areas to accommodate motor traffic without serious deterioration of the environment.

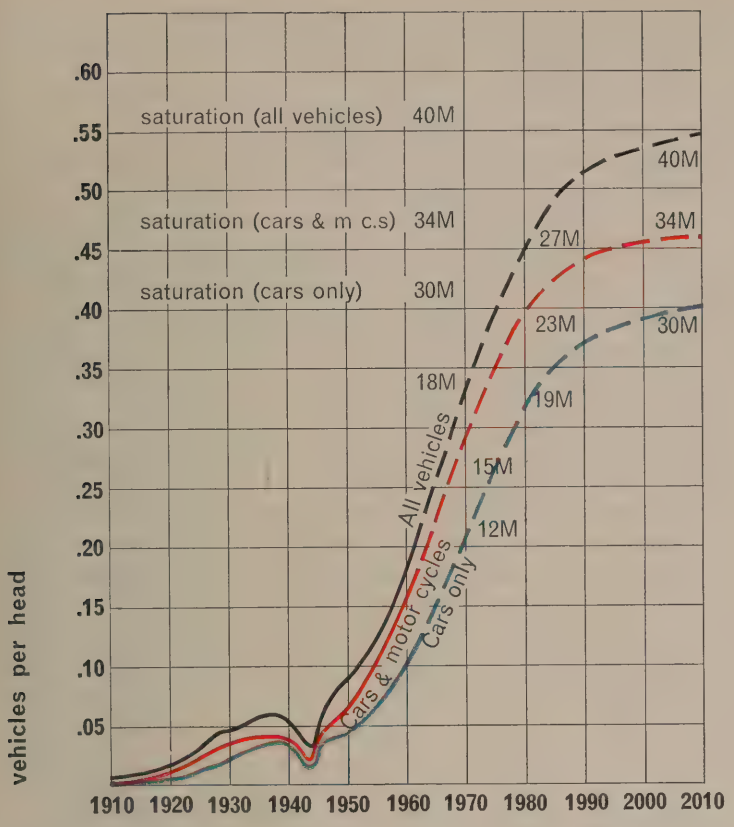
45. With so many variables and imponderables, the assessment of the future number of vehicles can proceed only by the projection of past trends and consideration of the recent experience of the United States.* On this basis, there is a prospect (in Great Britain) of 18 million vehicles (including 12 million cars) by 1970, of 27 million vehicles (including 19 million cars) by 1980, and perhaps of 40 million vehicles (including 30 million cars) by 2010. There are at present (early 1963) some 10½ million vehicles, so what is involved is a doubling of numbers within 10 years, and nearly a trebling within 20 years. It is important to note that nearly half the total increase is expected *within the first ten years* (Figure 38).

46. The figures given above take account of the estimated increase of the national population to some 74 millions by the year 2010.† The significance of this particular date (or thereabouts) is that it is likely to witness the saturation point, or the stabilising of the ratio of numbers of vehicles to population. In other words, most of the people who want cars will by that time have secured them. The total number of vehicles will still continue to increase if the population increases, but not at the rate that can be expected in the next twenty years.

47. Various ratios are in use to express the relationship between vehicle numbers and population. We are inclined to think that the *number of vehicles per* 1000 *population* is the most expressive, though, in respect of cars, another meaningful (even if somewhat imprecise) ratio is the *number of cars per family*. Expressed in these terms, the figures given above for the year 2010 would be 540 vehicles per 1000 population, 405 cars per 1000 population, and 1·3 cars per family.

* See, for example, 'Forecasts of Future Numbers of Vehicle in Great Britain', by J. C. Tanner of the Road Research Laboratory, Department of Scientific and Industrial Research, published in *Roads and Road Construction* September 1962.

† This estimate is based on the projection for a 40-year period contained in the December 1962 Quarterly Return of the Registrar General for England and Wales, and the 20-year projection in the 1962 Annual Report of the Registrar General for Scotland.



38 Future growth of numbers of vehicles. These curves indicate the probable trend assuming no drastic restrictionary measures are applied, and allowing for the future growth of the population.

Increase in traffic

48. These are increases in the *numbers* of vehicles; the increase in the *usage* of vehicles (i.e. traffic) may well be in a greater proportion than this. Not only is usage held at an artificially low level at present by congested road conditions, but American experience shows that as vehicles increase in numbers the usage per vehicle also tends to increase—at any rate up to the point at which there is an average of one car per family. On the basis of these figures, therefore, traffic may be more than trebled in a little over twenty years. This forecast, however, is for the country as a whole, it does not follow that *urban* traffic will be trebled everywhere; indeed there are likely to be important differences in the amount of increase as between urban, suburban and country districts. On the other hand, with the great increase of car ownership, peak-period traffic flows associated with towns may be more than trebled. There are also likely to be considerable differences between various parts of the country. In particular, the rate of increase in south-east England looks like being much faster than the national average unless some more far-reaching national policy for preventing it is adopted than yet seems to be in sight.

49. It will be asked what certainty there is that these very considerable, and in the circumstances of this small country, somewhat intimidating, increases of vehicles and traffic will really come about. The answer appears to be, on the assumption that the population increases in accordance with the forecasts, that an increase up to a total of 25 million vehicles (including $17\frac{1}{2}$ million cars, or an average of one car per family) must be regarded as virtually certain. Beyond this, the increase is perhaps more speculative. On the other hand it is our view that nothing would be more dangerous at this critical stage in planning for the new mobility offered by the motor vehicle, than to underestimate its potential. Most previous studies have failed in this way. It does seem possible now to look ahead to the full development of the situation, and this is what we have endeavoured to do, preferring the risk that we have slightly overestimated to the accusation

that we have failed to foresee the trend, or have deliberately glossed it over in order to make it seem less alarming or less demanding of expenditure on capital works.

50. Two rough checks can be applied to these forecasts. First, a comparison can be made between the present number of licensed drivers (in 1962, 12·9 million including 1·6 million provisional licence holders) and the *potential* number in the year 2010. The latter figure, based on a population of 74 millions, and allowing for people infirm, in hospital, in prison, disqualified, etc., and assuming the licensable age as between 16 and 70 years, would be unlikely to exceed 47·5 millions. At a ratio of one vehicle for each licensed driver (a somewhat higher figure than at present) the total number of vehicles would be 47·5 millions. This probably represents the extreme limit of possibility. In practice it is very unlikely that everyone potentially capable of holding a driving licence would in fact do so. Assuming that only 75% do so, and again taking the ratio of vehicles to licensed drivers at 1 : 1, then the total number of vehicles would be about 36 millions. Secondly, a direct comparison with American figures shows that if the present ratio of 410 vehicles per 1000 persons which obtains in the United States, were to be applied to a population of 74 millions in this country the number of vehicles would be about 30 millions. But if the expected U.S. saturation level of 550 vehicles/1000 persons is applied the total here would reach 41 millions.

An urgent situation

51. Irrespective of the exact final total of vehicles, however, we cannot emphasise too strongly the fact that vehicle numbers are likely to double within ten years, and to treble in a little over twenty years, and that this will be the bulk of the future increase. *The problems of traffic are crowding in upon us with desperate urgency.* It is sometimes maintained that these increases will not come about, that would-be owners of cars will be deterred by congestion and frustration, but we think this attitude would amount to a miscalculation of the mood of the country. The population appears as intent upon owning cars as the manufacturers are upon meeting the demand.

The increase of private mobility

52. One matter of importance is obscured by global figures. It is the distinction between the future growth in numbers of business, commercial and industrial vehicles (including many cars) on the one hand, and of private motor cars on the other. It only requires a glance at a map showing the land uses in a town to reveal what the future holds. The areas used for commerce and industry are limited in extent, they may be intensively developed and seething with activity, but the commercial and industrial traffic they generate is rational and calculable, for it is closely related to the activities going on. The residential areas on the other hand occupy by far the greater part of the town, and it is within these that there lies the huge potential for the future increase of traffic. It is here that personal mobility will increase, and people will seek to use their cars for journey-to-work, for shopping, for visits to friends and theatres, and for a great range of other social activities and daily errands.

53. A possibility which has to be borne in mind is that outright ownership of a motor car will soon cease to be a 'status symbol', and that, as a consequence, new systems for the use of cars will come into being. There could, for example, be a much extended use of hire-cars, or more widespread taxi services. These would have their effect on traffic volumes, and the space required for parking and storage. This is clearly a line of development that needs to be kept under review, but our inclination is to think that the effects are likely to be marginal only; for whether or not a motor car is a status symbol, there is no doubt that to many people it is a fascinating possession, and to have one at one's immediate beck and call is an asset of the first order.

The form of urban areas

54. We have shown that not only does the motor vehicle appear to have a long term future in its own right, but there is also a very large potential demand for its services. This means that unless something is done the conflict between towns as at present arranged and motor vehicles as at present used is bound to get progressively worse. It can be said categorically that the potential numbers of vehicles in towns are beyond anything that could be dealt with by one-way streets, waiting prohibitions, or other manipulative measures. This assumes, of course, that we do desire both to exploit the door-to-door usefulness of the vehicle and to accommodate it decently.

Influence of the motor vehicle towards dispersal

55. The conflict between towns and traffic obviously stems from the physical structure of towns. The manner in which the buildings and streets are put together is basically unsuitable for motor traffic. This soon became apparent after the invention of the motor vehicle because it soon exerted a strong influence towards changing the form of towns by encouraging the outward spread and sprawl of development. There have been two main reasons for this: first, the spatial demands of the vehicle itself for circulation and parking; and second, the facility of movement which the motor vehicle provides, whereby (to take an extreme example) a factory can be set up in a rural area without any serious difficulties arising over the recruitment of labour or delivery of goods.

39 '. . . the outward spread and sprawl of development'.

56. A case can be argued that if this is indeed the 'natural' influence of the motor vehicle, and if we are to have motor vehicles in very large numbers, we might as well go the whole way with this dispersal of urban areas. It can be argued that, with the added advantages of new telecommunication techniques, there is no longer any need for concentrated towns in the traditional form. Offices and exchanges can keep in close touch even though separated by long distances. Shops, it is said, give better service in suburban areas than in crowded city centres. Theatres restaurants, museums, clubs, zoos and the other things we have previously thought fit to concentrate in centres, could just as well be scattered about, provided they were intelligently sited in relation to a main highway network, and in this way they might be even more accessible to more people than they are now. What does a 30 mile drive to a theatre signify if it can be comfortably made in 30 minutes?

Population growth and the need for redeployment

57. The future form of urban areas is complicated by two other factors. The first is the need to deploy a probable population increase of over twenty millions soon after the end of the century; and the second is the

continuing need to redeploy population and activities from the large overcrowded cities. These two factors, in conjunction with the basic dispersive influence of the motor vehicle, make up a very powerful force towards a spread of development. There is no doubt that if it were left to itself it would rapidly result in a great part of the country, but particularly the south-east, being covered in vast irregularly-shaped sprawls of building. So far, with our green belt and countryside conservation policies, we have managed to keep the situation under control, but the pressures are present nevertheless, and are increasing all the time.

40 '. . . the continuing need to redeploy population and activities from the large overcrowded cities'.

58. The actual manner in which the population might be deployed is beyond the scope of this study. To start on this would be to embark on the preparation of a national plan. Certain general points which are relevant to the problems of motor traffic need to be mentioned, however, and these are dealt with below. Meanwhile a word of caution is necessary regarding the more startling proposals which appear from time to time for various theoretical urban forms based on transport systems—linear cities, annular cities, radial cities, satellite systems, etc. It is a healthy sign that such ideas should be put forward, and the day may come when, suddenly, there is a crystallisation of views and it is clear that we should steer a new course. But this has not happened yet. For the period ahead into which we may reasonably peer—probably extending but a little beyond the end of the century—it is reasonable to suppose that towns and cities will continue to exist broadly in their present form, for in spite of their acknowledged defects they contain great accumulations of material and cultural wealth. We can see that an enormous increase of population over the next decades might require the urbanisation of large new areas, where the capacity of existing towns to expand is quite inadequate. In such a case the new urban settlements could well take on new forms based on transport systems. But this development would be complementary to existing towns and cities and would not alter the need for the methodical overhaul of the latter.

Importance of the study of movement

59. In the first place (to return to the thread of the argument), in all consideration of urban form, from the expansion of existing towns to the complexities of 'urban regions', the question of facility of movement of both persons and goods is of crucial importance. It deserves far more attention than has been bestowed on it in the past; indeed it can be said that it must now become one of the prime factors in the determination of where population and activities are to be settled. If this is to be the case, however, a much greater understanding of the relationship between various kinds of development and the demands for movement which they generate needs to be developed. In this largely neglected field of research there is a great deal to be learned from current techniques in the United States. It is important that movement demands be studied as a whole, not merely those that involve the motor vehicle, because all the indications

(including those from the United States) are that in a complex community no single system of transport can provide for all the movements involved, and that co-ordination between systems is required.

A small island

60. In the second place it is important to recognise that, although persuasive arguments can be adduced in favour of urban dispersal, this island is not big enough for large scale dispersal if a sensible relationship is to be maintained between developed areas and open country. Opinions may vary as to the future role of agriculture, but no one could question the special importance of the countryside to the people of this crowded island, or be prepared, when really faced with the issue, to see a large part of it sacrificed to a major dispersal of urban areas in order to accommodate motor traffic. After all, to 'get out into the countryside' is one of the main reasons why people buy cars.

Dangers of sprawl and the virtues of compactness

61. Thirdly it should be understood that dispersal, if taken beyond a certain point, positively complicates transportation problems by increasing all the distances that have to be traversed. Dispersal, in fact, can all too easily become synonymous with 'sprawl', and if there are not already sufficiently bitter lessons to be learned about sprawl in this country, one only has to turn to the United States to see what happens when the motor vehicle is given free license to lead development where it will.

62. Fourthly, there are long-standing, well-tried advantages in the principle of compactness for urban areas which are not to be lightly jettisoned in favour of the supposed advantages of dispersal. In a compact area, journey distances, including the all-important journeys to work and school, are kept to the minimum. The concentration of people makes it possible to provide a diversity of services, interests and contacts. There is a wider choice of housing, employment, schools, shops and recreational and cultural pursuits. It is easier in a compact society to maintain the secondary activities, such as restaurants, specialist shops and service industries which all too easily fail if there is not a large enough clientele close enough at hand. The issue is not starkly between high-density flats and low density suburbs—it is desirable that towns should have some of both—but whether to maintain or abandon the degree of compactness and proximity which seems to contribute so much to the variety and richness of urban life.

A problem of design

63. But whatever decisions may be reached about the deployment of the population, if sprawl is avoided, there will still be towns which are closely-knit concentrations of development, in principle not unlike those we have today. Some will be old towns subjected to violent new stresses and strains as a result of the addition of population, some will be new towns, and others will be large cities, or groups of cities, exerting an influence over smaller settlements for many miles around. In all these one common problem will arise: how can these agglomerations of houses, factories, shops, offices, markets, warehouses, schools, hospitals, depots and yards be adapted to meet the wishes of people seeking to use motor vehicles of all kinds for every imaginable purpose of transport? Even where a completely *new* town is being built the question still is: how can the activities be arranged, and the buildings disposed on the ground, to enable the use of motor vehicles to the best advantage? These questions indicate a problem of *design*, of the actual layout and form of buildings and access ways, and the manner of distribution of traffic from one part of a town to another. It is a basic problem, as relevant to a small isolated town in East Anglia as to the constituent towns of the largest conurbation. It was to this basic, common problem that we considered our efforts should be primarily directed, to see whether there were principles to be followed, and to disclose the possibilities and, perhaps, the limitations.

What sort of towns?

64. This, subject to two further questions, seems to establish the context of this study. The remaining questions are perhaps the most important of all. What sort of towns ought we to be thinking about in the latter half of the twentieth century? And what are we likely to be able to afford for change and renewal? As to the first question, we know now, by bitter experience, that the motor vehicle is in conflict with the present structure of towns. By it, and because of it, grievous damage has been done to many of the things we have previously cherished. All the indications are that given its head the motor vehicle would wreck our towns within a decade. What should we expect of towns? Is it merely a matter of material convenience and accessibility for cars, or, for example, does it matter any longer what towns look like? It is an indication of the influence of the motor vehicle that it makes us take stock of these things, even to the extent of asking what sort of lives we want to lead.

65. The importance of towns lies in the fact that nine-tenths of the population of the country lives, and in all certainty is going to go on living, in towns large or small. Towns are the setting in which millions of people have to live out their lives. The influence of physical surroundings upon people's lives is only now being learned. The beneficial influence of good housing, of good schools, of offices with sufficient space and adequate daylighting have already been discovered. The value of open spaces has been learned. More subtly, many people are discovering possibilities in the interior design of buildings—sheer convenience, colour, relationship of spaces and levels—of which they had no previous inkling. But as yet the possibility that our daily surroundings, outside our houses and offices might be amenable to design in the same way for our delight and convenience is slow in being understood, though, judging by the numbers of visitors to famous cities—Venice, Paris, Oxford, Norwich, Cambridge—there must be something in the way some buildings have been designed and grouped that touches a chord of understanding in many people.

41 '. . . people are discovering new possibilities in the interior design of buildings . . .'.

66. The overriding context in which the problems of urban traffic have to be considered is the need to create or re-create towns which in the broadest sense of the term are worth living in, and this means much more than the freedom to use motor vehicles. It is a mixture of all manner of things—convenience, variety of choice, contrast, architecture, history visible in the buildings—all more or less subtle qualities. Life in towns could no doubt be lived without any of them, but it would be a poorer and emptier life as a result. The town planner is in an uneviable position—blamed if opportunities are missed, accused if he tries to tell people what they should have. But of this there can be no doubt, that there are potentialities for enriching the lives of the millions of people who have to live in towns beyond anything most of them have yet dreamed of. It is in the context of a belief in the importance and potentialities of towns that the problems of motor traffic have to be considered.

42 '. . . but the possibility that our daily surroundings outside our houses and offices might be amenable to design in the same way is slow in being understood'.

How ambitious?

67. Finally there is the question: how bold can we afford to be? This is really a matter of the faith we have in our own future as a nation. If we believe we have a great future then we *must* also believe that the standard of living will go steadily up, riding over the ephemeral ups and downs of economic life. The long term view must surely be an optimistic one, a belief that we shall have the resources to remould our environment to our liking. The trouble is that urban re-development is a long, slow process, which is fatally inhibited by short term, parsimonious decisions. The opportunity missed today will still be lost, and more bitterly regretted, in fifty years time. If we believe in our future, then surely we must hitch our re-development investment to that belief at once, and not be content with making-do today in the vague hope that we can really start tomorrow. In these matters there is no true distinction between the short term and the long term.

Chapter II: The theoretical basis

68. The preceding chapter described our search for a context in which to work. We concluded, since it is obviously the desire of society to use the motor vehicle to the full, that the only practical basis for a study of the present kind was to accept this desire as a starting point and then to explore and demonstrate its consequences. This does not mean that the desire is necessarily capable of fulfilment, nor does it rule out the possibility that society, when it learns the full nature of the consequences, may wish to withdraw or amend its desire. Indeed it can be said in advance that the measures required to deal with the full potential amounts of motor traffic in big cities are so formidable that society will have to ask itself seriously how far it is prepared to go with the motor vehicle. This is the main question involved in the so-called urban traffic problem.

69. We also concluded in our general review that our task essentially was to explore a problem of design—the design of physical arrangements of buildings and access ways.

70. Within this context we then directed our study more closely to the actual problems arising from the use of motor vehicles in urban areas in order to see whether we could evolve some working principles for dealing with them. We did not do this entirely *in vacuo*, but by a combined process of searching for principles and studying actual cases. We think it will make for better understanding, however, if we set down the broad theoretical approach first, and follow it up in the next chapter with a description of the practical studies on which it has been tested.

The nature of urban traffic

71. We decided we would need to attach a broad meaning to the term *traffic* to include the presence in towns of vehicles *both moving and at rest*. Within this definition we then sought to understand the nature and causes of traffic. If this seems an elementary approach, the explanation is that this vital aspect of the subject has been largely overlooked. A great deal of thought has been given to the engineering aspects of traffic flow—to the measurement of traffic volumes, and to the design of roads and intersections to promote the efficient movement of vehicles—but it has seldom been deemed any part of the responsibility of those working in this field to ask *why* the vehicles should be moving, nor whether the traffic might not be enabled or directed to move in some quite different way by manipulation of the causes of movement. The ability to look at the matter in a wider way has rested in theory with the town planners, but owing to a long-standing hiatus between town planning and road planning activities it has never been exercised effectively.

Traffic a function of activities

72. Vehicles do not of course move about the roads for mysterious reasons of their own. They move only because people want them to move in connection with activities which they (the people) are engaged in. Traffic is therefore a function of activities. This is fundamental. This explains

43 The inherited road system. Direct links from town centre to town centre, forcing all long-distance traffic to pass through the middle of towns.

why there is so much traffic in towns—because activities are concentrated there. It explains why traffic flows between towns, and between town and countryside—because there are complementary activities generating cross-movements. Activities are numberless, but there are only four basic ways in which motor vehicles are used in connection with these activities:

1. Transport of raw materials, merchandise and food.
2. Conveyance of passengers in bulk (buses, coaches, etc.).
3. Conveyance of persons individually or in small numbers (cars, motor cycles, etc.).
4. Mobile services (fire engines, clinics, libraries, etc.).

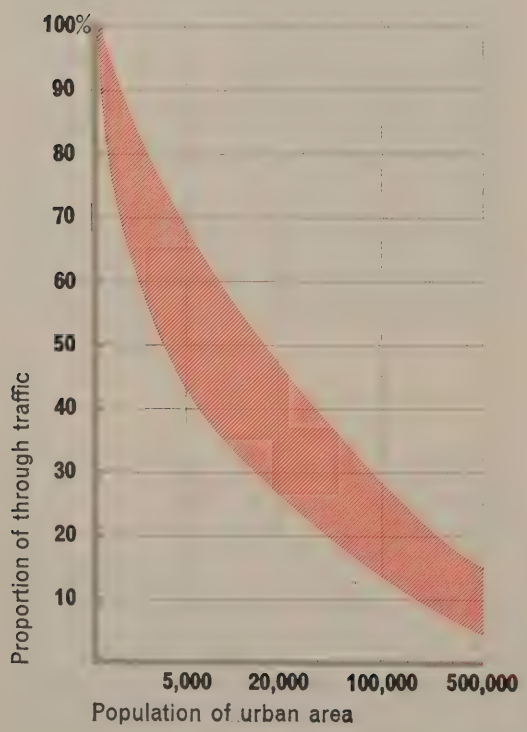
73. The proportions of vehicles used in these four different ways naturally vary between any one body of traffic and another, and between one town and another, according to the nature of the activities carried on. There are regional differences too—the proportion of private cars, for instance, tends at present to be higher in the southern parts of England than in the north.

Essential and optional traffic

74. Within this four-fold classification of the use of vehicles there is one simple distinction of great importance. It is the difference between the use of vehicles for *essential* purposes in connection with trade, business, and industry, and the *optional* use of cars for private pleasure and convenience. The full importance of this will become clear later on; it is enough to say at this stage that the essential traffic is, in theory at any rate, calculable, for it is related to known or predictable trading and manufacturing processes, and to other predictable social and emergency services. The use of cars for optional purposes on the other hand depends on many uncertain factors, from the whim of the owner to the state of the weather, and it is often alternative to some other means of transport by which the journey could have been made.

The problem of through traffic

75. With this picture in mind of the general nature of traffic, the position within towns can be considered more closely. The first point to note is that in every town there will be a certain amount of traffic, on all approach roads, which passes straight across the town without stopping to conduct any business. This is the phenomenon of *through traffic*. The presence of through traffic in towns is explained by the nature of the road system which we inherited from the pre-motor age. This consisted essentially of direct links from the centre of one town to the centre of the next, with a close mesh of local roads within each town giving direct access to the buildings, and a much broader mesh over the countryside to serve the small settlements, farms and fields (Figure 43). Although this network has discharged an enormous amount of traffic, and is perhaps the most comprehensive penetrative network of any country in the world, it is clear that apart from the narrowness of the roads it has one outstanding weakness for modern traffic. The direct links from town centre to town centre served admirably when a town-to-town journey was about as much as a coach-and-horses could manage in a day. But they are most unsatisfactory for the long-distance journeys which the motor vehicle has made possible, because all vehicles are forced through the middle of towns whether they want to go that way or not. This is the reason for the presence of through traffic.



44 Relationship between town size and the proportion of by-passable traffic on the approach roads. The larger the town, the smaller is the proportion of through traffic.

76. It will be asked how far through traffic is the cause of the difficulties now arising in towns, and whether the simple answer is not to embark on an extensive programme of 'by-passes'. The answer to this question is that much depends upon the size of the town. In large towns there is so much local traffic, and so much of the traffic on the approach roads is bound for the town in any case, that the removal of the through traffic makes very little difference (Figure 44). This is not to say, however, that there may not still be enough through traffic to warrant a by-pass for its own sake.

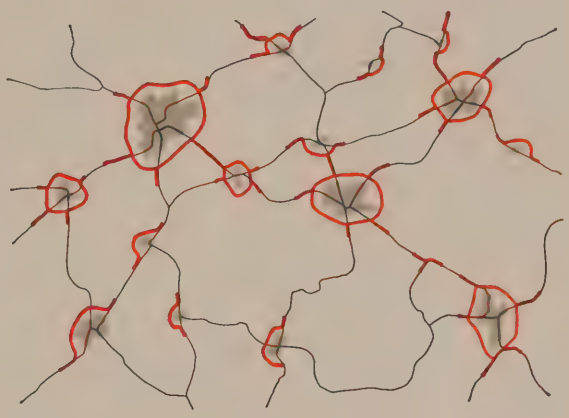
77. In the case of small towns, however, especially those situated on main routes between large towns, the through traffic may be an important

element in the congestion. Indeed the position is now arising in which literally thousands of small towns, villages and hamlets are presenting a case for the removal of through traffic on the grounds of the nuisance and danger which it causes within the settlement. By-passes in these cases would give much-needed relief, though not necessarily permanent relief in view of the way in which local traffic is itself likely to increase in the future. It may be noted that so far, in our system of highway administration, the case for by-passing a settlement has rested primarily on the degree of obstruction offered by the settlement to the passage of through traffic. It would amount to a major shift of emphasis to include also, as a main criterion for by-passing, the degree of nuisance offered by the passage of through traffic to the settlement.

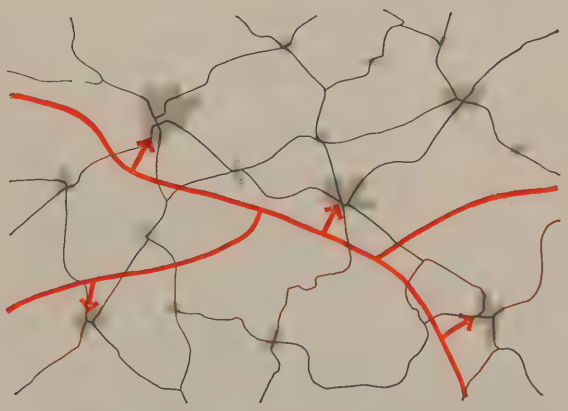
78. The global liability for by-passing would appear to be very large. If every settlement, large and small were to be by-passed in every necessary direction, as shown in Figure 46, the total requirement would be so demanding of land, and so disruptive of farming, that one has to question its practicability. An alternative would be to develop a more skeletal network, as shown in Figure 47, onto which the longer flows of traffic would be concentrated, with lateral spurs leading to settlements. This would require a considerable disciplining of traffic so that vehicles moved from place to place on the network, even at the expense of longer journeys, rather than along the old roads through the settlements. It would be outside the scope of this study to pursue these two alternatives in detail, or combinations between them. The main point to be made is that through traffic is a complicating factor in towns, which first needs to be disentangled from the problems of town traffic proper, and then needs careful consideration for the best way to deal with it.

79. One last point requires to be mentioned in connection with by-passes. It concerns the opposition which proposed by-passes nearly always arouse from traders who fear loss of custom. Such opposition may be well-founded in the case of a settlement which has come to the point of being almost entirely dependent upon the passing traffic, with restaurants, cafés, repair garages, filling stations and second-hand car sales. But in the normal small town or village, which is a more-or-less self-contained entity where people live and work, the case that removal of through traffic may have disastrous commercial effects can no longer be taken seriously. Already in many such towns the through traffic is an unmitigated nuisance, but this is nothing compared with the situation which is bound to arise as traffic increases. It is characteristic of most of our towns that the main streets are narrow. This is perhaps fortunate, for otherwise we might be tempted to leave them as through traffic routes, and thus repeat the 'race-track' villages of France which are so disastrously bisected by heavy flows of fast traffic. There is an important moral here. It is asking for trouble, especially in the case of small towns, to attempt to deal with through traffic by widening the internal streets—this will merely speed the through traffic, accentuate the severance, and, by virtue of the slight improvement offered to through traffic, delay the undertaking of more constructive measures.

45 '. . . thousands of small towns, villages and hamlets are presenting a case for the removal of through traffic'.



46 The by-passing of every settlement in every direction would pose a heavy liability in terms of cost, land and severance.



47 The alternative to universal by-passing is a skeletal system involving disciplined movement.

Town traffic—a function of buildings

80. As mentioned previously, traffic is a function of activities, and traffic is concentrated in towns because activities are concentrated there. It is characteristic of activities in towns that they mainly take place in *buildings*, or in places such as markets, depots, docks and stations which for the purposes of this description can be termed 'buildings'. In *towns*, therefore, traffic can be said to be a function of *buildings*. It is broadly true to say that *all* the movements by vehicle that take place in the streets have an origin or a destination in buildings, of one kind or other in some place or other. Some of the vehicles will be moving within the town from building to building, others will be making their way from outside the town to buildings within it, or vice versa, whilst still others will merely pass through the town in the course of moving between origins and destinations, both of which lie outside the town. Disregarding this through

traffic, a simple but very important fact emerges—the patterns traced by all the vehicles as they move about are *closely related to the manner in which the buildings are arranged.* In a simple village street for instance the movement patterns are correspondingly simple, but in a city with buildings jumbled together, and even piled on top of one another, the journey patterns naturally become very complicated. It is this jumbled arrangement of buildings that is as much the cause of traffic difficulties in towns as the narrowness of the streets and the frequency of intersections. Vehicles making for particular buildings weave a complicated web of penetrative criss-cross journeys, and get in each others' way at every turn as they zigzag through the web of streets. Mere widening of the streets does little to ease these conflicts. It is an important characteristic of the New Towns (where it was possible to design afresh) that the buildings are generally arranged in simple clear-cut patterns, and similar kinds of buildings are grouped together in zones.

81. It is most important to recognise this connection between vehicles and buildings, and the complicated circulation pattern that results from a complicated arrangement of buildings. This is something which has not been properly understood in the past and which has not been revealed by the standard kind of 'origin and destination' survey. Virtually every building in a town has now become dependent for its continued functioning upon frequent servicing by motor vehicles. The vehicles so used have to worm into and out of every corner. Cars seek to penetrate everywhere. Buses need to be routed close to buildings. *The journey patterns are extremely complex.*

82. The great majority of the buildings in the towns of this country can be classified under six main headings—Industry, Warehousing and Wholesale Distribution Centres, Shops and Retail Centres, Offices and Public Buildings, Schools and Dwellings. It is the movements between these main groups (to the extent that they take place by road, which is considerable) that constitute the bulk of the traffic in the streets. To recognise the nature of these movements is an important part of the task of dealing with urban traffic.

48 A desire line diagram (see para. 84) for work journeys in a small town.

83. Whilst the basic movements admit of fairly easy classification, there is an overlay of miscellaneous journeys which complicates the position almost beyond description. There are, for example, journeys between homes and entertainment, the latter being centrally situated (e.g. theatres) or at some particular place such as a football stadium or cricket ground. There are the journeys of doctors on their rounds, rambling journeys from house to house. There are the journeys of police patrolling the streets, of ambulances going to accidents, and of fire engines out on call—these three, although not numerous in relation to the basic flows, are important when it comes to the *design* of building arrangements because the vehicles involved must be able to penetrate almost everywhere. Then there are the journeys of furniture vans, hearses, ice-cream vans, postal and telephone vans, and vehicles used for many occasional purposes. An extremely important group of journeys are those made in connection with building operations—a big contract may impose a heavy extra load of traffic on the surrounding streets for many months.

Journey to Work

84. Certain other features of urban movement may now be distinguished. One of the most basic is the linkage between homes and places of work. In most towns the locations of employment are found to be arranged in a limited number of main groups, together with a considerable scattering in other parts of the town. Every morning, and in the reverse direction every evening, great tidal flows of movement take place between the residential areas and the places of work. The pattern of journeys involved is vividly shown in Figure 48 which is a 'desire line diagram' for the work journeys in a town of 30,000 inhabitants. (In such diagrams the commencement and termination of all actual or predicted journeys in a given period of

time are represented by points on a map. These points are connected by a straight line to represent the general direction of movement. The thickness of a group of lines thus represents the *number* of journeys in a particular direction.)

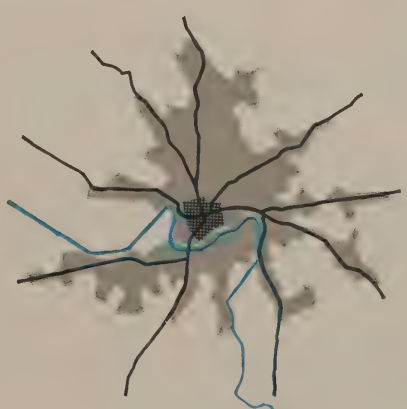
85. The pattern of travel to work has been becoming more complicated in our big towns over the last half century. As the towns have grown, new dwellings have been constructed round the periphery because no other locations were so readily available. The occupants of these new dwellings, however, have been mainly dependent for employment upon the established work centres. In the replacement of slums also, as a reaction against the crowded conditions of the 19th century, the new houses have sprawled out in suburban estates. This dispersal has brought about better living conditions for millions of people, but the benefits are now tending to be offset by the increasingly difficult travelling conditions which the dispersal has brought about.

86. A new phase is now starting in the phenomenon of journey to work. At first, the development of the great suburban sprawls was largely made possible by bus services, though in London and certain other places the suburban railways and undergrounds played a large part. But with the rising standard of living and the consequent increase of car ownership, and because in many places the public transport services seem unable to cope with increased demands, far more people are now seeking to use *cars* for the journey to work. This is causing the now familiar 'downward spiral' whereby public transport loses custom, cuts its services to make up the loss, and then, partly as a consequence of its cuts, tends to lose still more custom.

87. In most towns the use of cars for journeys to and from work already dominates the traffic picture, and produces the familiar morning and evening 'peak periods'. As will be shown later, it is this particular form of usage of the motor vehicle that constitutes one of the crucial issues in the urban traffic problem. Closely associated with this is the *duration* of the peak period—if everyone insists upon travelling at the same time, then more elaborate systems are required than if the journeys are spaced out.

Movement within town centres

88. The densely developed *centres* of towns and cities naturally tend to generate a great deal of movement. But they have become so embedded and constricted in vast expanses of surrounding development that movement within them and to them is understandably meeting difficulties. This is particularly the case with motor traffic, much of which is attracted in from other parts of the town, or from outside the town altogether, but which then has to filter through streets and localities with which it has no concern whatsoever. The power of town centres as generators and attractors of traffic seems not to have been fully understood, and mistaken reliance has been placed on ring roads for the relief of central congestion when in fact much of the traffic has business in the central area, and is not divertible to places outside that district. This is not to say however that in any particular case there could not be enough traffic that *is* divertible to justify a diversionary road *for its own sake*, the mistake arises in presupposing that the diversion is bound to have a marked effect on central congestion. There is a very close parallel here with the question of by-passes for whole towns—it is important in both cases to distinguish which objective the by-pass or diversionary ring is designed to achieve: whether it is the interest of through traffic or local congestion.



49 Town centres embedded and constricted in vast expanses of surrounding development.

Road versus rail for town traffic

89. At this point reference may be made to a notion that seems to lurk in the back of many people's minds, namely that most of these problems of motor traffic in towns are unnecessary and could be disposed of by getting much of the traffic back to the railways. It is quite possible that *some* traffic could be transferred to the railways—other things being equal, many

more goods sent from Birmingham for the London market, for example, could be despatched by rail, and thus the long haul of lorries across much of London would be saved. But the problem of the final distribution from the railhead in London to the building destinations would still remain, and the odds are strongly in favour of road transport being chosen for this purpose. Thus the net reduction of motor vehicle haulage within the London area would not be as much as at first sight seemed possible. The reason of course is that it is quite impossible to contrive separate rail connections to all buildings, but such is the versatility of the road vehicle that it *can* penetrate to individual buildings. It is worth recalling that even in the heyday of the railways the local distribution from railheads, goods yards, and docks was effected by road. Then lorries were substituted for the local horse-drawn vehicles, and then it was discovered that they could perform the longer hauls as well, and so deliver goods to destinations in one journey without an intermediate re-loading. In much the same way the motor car offers outstanding advantages over railways, or even over buses, for certain movements of people. It seems futile to deny these things. The motor vehicle is a remarkable invention, so desirable that it has wound itself inextricably into a large part of our affairs. There cannot be any going back on it.

The essence of the problem

The inherited urban road system

90. In exactly the same way that the rural and inter-town road system which we inherited from the pre-motor era has proved to be unsatisfactory for motor traffic, so also has the internal road system of towns. In the first place the *layout* of the streets has not been suitable for the movement of motor vehicles (Figure 50). To develop its characteristics a motor vehicle requires a reasonably clear, uninterrupted run, but in the close criss-cross layout of our urban streets there are intersections at very frequent intervals and each one of these is a potential obstruction to the flow. These are the scenes of the notorious 'right hand turns' which cause so much delay. Then many of the streets are too narrow for the number of vehicles which seek to use them. The vehicles have increased in number, it should be noted, partly on account of the sheer growth of the motor vehicle habit, and partly because we have permitted the increase in the size and amount of accommodation in buildings without realising that this would bring more traffic onto the existing streets. If the close connection between buildings and the motor traffic that they generate had been understood this might not have happened.

50 The inherited urban road pattern—irregular alignments, narrow streets, frequent intersections.

91. Another great difficulty of the inherited road system of towns arises from the unfortunate fact that access to the great majority of buildings is gained direct from the street onto which they front: the flow of traffic is obstructed every time a vehicle pulls up to deliver callers or goods. A further difficulty, only too well known, is the shortage of places where vehicles can be parked. The streets themselves provide only a very limited (and then seldom really satisfactory) supply of parking spaces, and few *buildings* in the inner, older parts of towns have internal space for parking.

92. The result of growing numbers of vehicles endeavouring to force their way through this narrow, intricate street system has been increasing congestion and inefficiency. Even so it might be thought that up to a point the system, in all the circumstances, has not served too badly, and even now in conditions of light traffic, it functions reasonably well. But with the increase of traffic in recent years its drawbacks for motor traffic are manifesting themselves only too clearly. Everywhere there are complaints of congestion, delays and difficulties of parking and loading and unloading goods.

Accessibility

93. We have sought for a term with which to describe the general idea of ease of access for vehicle users. We have not found a better term than *accessibility*, though we would have preferred a shorter word. There are two main requirements for good accessibility. First, vehicle users should be able to move from one part of a town to another—or beyond, in safety and with reasonable speed, directness, and pleasantness from the 'driver's eye view'. Second, on arrival in the vicinity of his destination, the driver should be able to penetrate without delay close to his final destination and to stop there without restriction.

Environment

94. Poor accessibility is not the whole of the traffic problem by any means. The penetration of motor vehicles throughout urban areas is bringing its own peculiar penalties of accidents, anxiety, intimidation by large or fast vehicles that are out of scale with the surroundings, noise, fumes, vibration, dirt and visual intrusion on a vast scale. Included in the last item is the proliferation of establishments serving or served by the motor vehicle. All this was discussed at length in the previous chapter, and it was concluded that these are indeed matters of the most serious concern.

95. A convenient term is required to convey the idea of a place, or an area, or even a street, which is free from the dangers and nuisances of motor traffic. The expression that immediately comes to mind is to say that the area has a good 'environment', but in point of fact this would convey to most people familiar with town planning terms a good deal more than just freedom from the adverse effects of traffic. It would, for instance, certainly convey the idea of a place that was aesthetically stimulating. We have given much thought to this point, but we have not found a term that is as meaningful as 'environment'. We have therefore decided to use it, clumsy though it is, but it should be understood that, unless otherwise qualified, it is used only to describe or assess the effects of motor traffic upon the surroundings. Thus a street of near-slum houses would not in the normal way be regarded as possessing good environmental qualities, but as far as traffic is concerned it could be quiet, safe, clean, uncluttered by cars, and safe for children. Within our definition therefore it could have a good environment that would be capable of being adversely affected by motor traffic.

Pedestrian movement

96. Closely associated with the quality of the environment is freedom of pedestrian movement. The simple act of *walking* plays an indispensable part in the transport system of any town. There is nothing fanciful in this statement. Walking accounts for many medium-distance movements, virtually all the final distribution from bus stops and car parks, and a vast

51 '. . . the freedom with which a person can walk about and look around is a useful guide to the civilised quality of an urban area'.

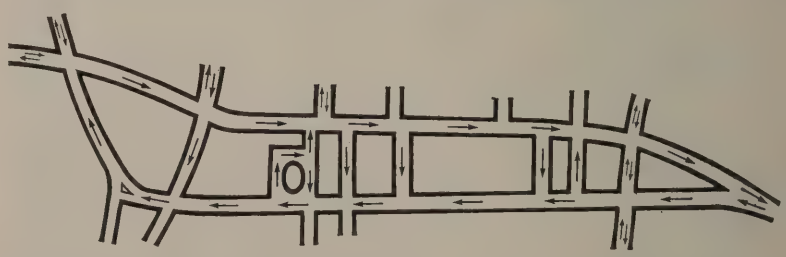
amount of casual coming and going. Nor is it to be discounted as a medium for the carriage of goods. It is therefore common sense that pedestrian movement should be enabled to take place in reasonable comfort and safety, and this can be said without appearing to be telling people what is good for their health. Walking is also an integral part of many other matters, such as looking in shop windows, admiring the scene, or talking to people. In all, it does not seem to be far from the truth that the freedom with which a person can walk about and look around is a very useful guide to the civilised quality of an urban area. Judged against this standard, many of our towns now seem to leave a great deal to be desired.

The Conflict

97. We concluded in the first chapter that to deal with traffic in towns involves a question of design, that is to say of re-designing the physical arrangement of the streets and buildings in order to cope better with the use of vehicles. We are now in a position to define this problem of design precisely: *it is to contrive the efficient distribution, or accessibility, of large numbers of vehicles to large numbers of buildings, and to do it in such a way that a satisfactory standard of environment is achieved.* How is this to be done in existing towns and cities with their established complex pattern of buildings and their medieval networks of narrow streets? Quite obviously it is a most difficult task. An inherent difficulty is that the two components of the problem—accessibility and environment—tend to be in conflict. A good environment in the special sense we use the term could be secured overnight by reducing the traffic in every street to appropriate levels. In some places this might not cause any real hardship to vehicle users (e.g. the establishment of a 'play street') but as an overall policy for a town it would seriously interfere with the functioning of the place. On the other hand the accessibility problem would certainly not be solved by sacrificing environment—it has practically been sacrificed already yet accessibility still presents difficulties.

98. Mention may be made here, in passing, of the new activity known as *traffic management.* It is not in fact really new, for the management of traffic started when 'Keep to the Left' was first thought of, but only in the last few years has it been consciously developed with the objective of 'getting the most out of the existing street system'. One-way streets and the elimination of right-hand turns have been the main features that have caught public attention, but there are also 'clearways', elaborate linked signal installations, the banning or strict control of parking and waiting in many streets, and the closer control of pedestrians. Whilst these measures have been of benefit to the movement of vehicles* it has to be admitted that some of them inhibit the very thing for which motor vehicles are so valuable, namely the ability to penetrate to individual buildings and to stop there. After all, the main purpose of nearly every street in every town is to give access to the buildings along it. Moreover, although in some cases it has been shown that accidents have been reduced, the general effect of these schemes is to increase the speed of traffic and, on the principle of spreading the load, to introduce traffic into streets where it is quite unsuitable, with consequent harmful effects on the surroundings.

52 A typical traffic management measure. The difficult right-hand turns out of the main route are prohibited at the points marked by red crosses, and are replaced by left-hand turns which take traffic round the block (as shown in red) to a straight cross-over of the main route.



53 A traffic management scheme showing the extensive use of one-way streets.

* 'The cumulative effect of various (traffic management) measures in the Central London area have been shown to have increased traffic speeds on main roads by 9% between the autumns of 1960 and 1961.' Dr G. Charlesworth, *Traffic Engineering and Control*, Vol. 4 No. 2 June 1962.

54 The principle of 'spreading the load' may introduce heavy traffic into streets where, environmentally, it is quite unsuitable. (This scene is viewed from a householder's front door).

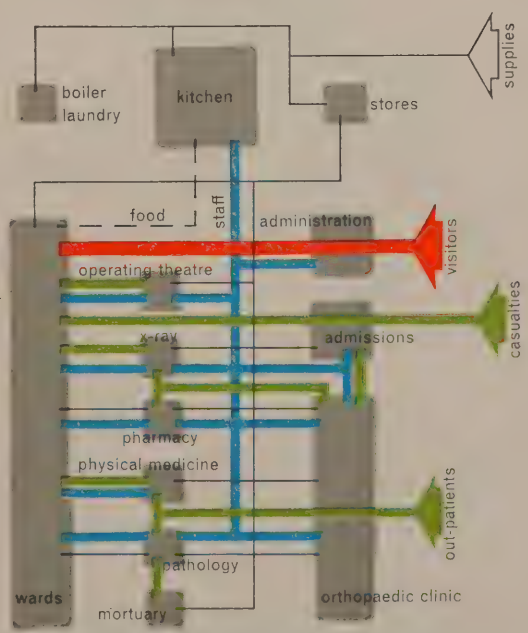
A working theory

99. The design problem, essentially, is a matter of rationalising the arrangement of buildings and access ways. At the extreme this can be seen to encompass the strategic rearrangement of activities to get them into better relationships. Examples would be to remove a wholesale market from an overcrowded centre, to remove a petrol filling station from a busy shopping street, or to get dwellings and workplaces into improved relative positions. All this should form an important aspect of town planning policy, as should the converse need to prevent new, undesirable relationships arising as a result of new development. But there is still a need to discern some basic principle for the design of buildings and access ways in order to secure good accessibility and environment.

The basic principle

100. Fortunately there is no mystery about this, because the problem is no different in its essentials from the circulation problem that arises every day in the design of buildings, where the subject is well understood. The basic principle is the simple one of circulation, and is illustrated by the familiar case of corridors and rooms. Within a large hospital, for example, there is a complex traffic problem. A great deal of movement is involved—patients arrive at reception, are moved to wards, then perhaps to operating theatres and back to wards. Doctors, consultants, sisters and nurses go their rounds. Food, books, letters, medicines and appliances of many kinds have to be distributed. A good deal of this includes wheeled-traffic. The principle on which it is all contrived is the creation of areas of environment (wards, operating theatres, consulting rooms, laboratories, kitchens, libraries, etc.) which are served by a corridor system for the primary distribution of traffic. This is not to say no movement takes place within the areas of environment, since even in a hospital ward there is a drift of movement up and down the ward, but it is strictly controlled so that the environment does not suffer. If for some reason movement tends to build up beyond the ability of the environment to accept it, then something is quickly done to curtail or divert it. The one thing that is never allowed to happen is for an environmental area to be opened to through traffic—food trolleys being trundled through the operating theatre would indicate a fundamental error in circulation planning.

101. There is no principle other than this on which to contemplate the accommodation of motor traffic in towns and cities, whether it is a design for a new town on an open site, or the adaptation of an existing town.



55 A typical circulation diagram for a hospital.

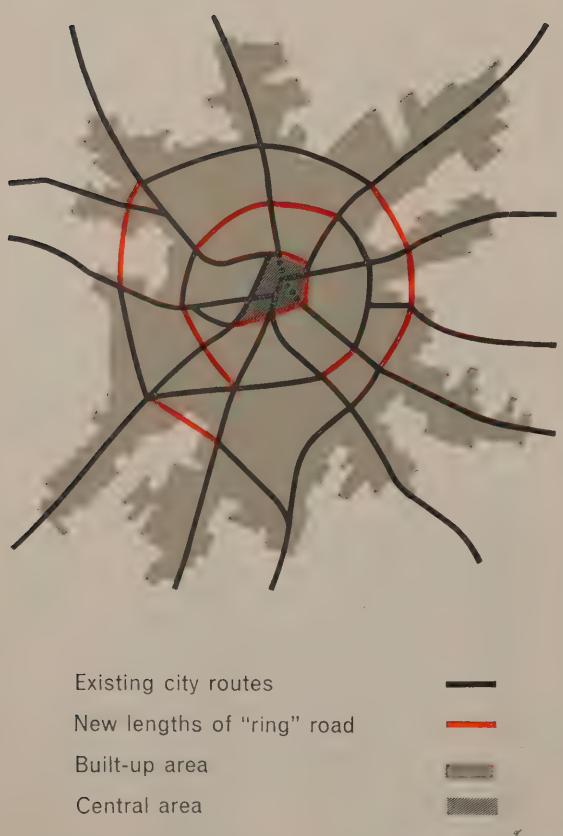
56 The cellular concept.

There must be areas of good environment—urban rooms—where people can live, work, shop, look about, and move around on foot in reasonable freedom from the hazards of motor traffic, and there must be a complementary network of roads—urban corridors—for effecting the primary distribution of traffic to the environmental areas. These areas are not free of traffic—they cannot be if they are to function—but the design would ensure that their traffic is related in character and volume to the environmental conditions being sought. If this concept is pursued it can easily be seen that it results in the whole of the town taking on a cellular structure consisting of environmental areas set within an interlacing network of distributory highways. It is a simple concept, but without it the whole subject of urban traffic remains confused, vague, and without comprehensive objectives. Once it is adopted then everything begins to clarify. It is not by any means a new idea, for Sir Alker Tripp was advocating something on these lines over 20 years ago†, and the precincts and neighbourhoods of the County of London Plan reflected the same approach. But in the face of the rapidly increasing number of vehicles it acquires a new urgency; it now requires to be explored and developed from a mere concept into a set of working rules for practical application.

Relationship between environmental areas and networks

102. Some implications of the concept may now be considered. As applied to a whole town, it would produce a series of areas within each of which considerations of environment would predominate. These areas would be tied together by the interlacing network of distributory roads onto which all longer movements would be canalised *without choice*. As explained previously, in principle it would not be unlike a gigantic building with corridors serving a multitude of rooms. The relationship between the network and the environmental areas would therefore be essentially a service relationship: the function of the network would be to serve the environmental areas and not vice versa. This may seem elementary but in fact it is one of the things which this approach puts into the right perspective, it brings it home that traffic and roads are not ends in themselves, they are services only, the end is the environment for living and working.

103. It follows from this that there must be a capacity relationship between the network and the environmental areas. As a rule, in most cases, the network would be designed to suit the capacity of the areas just as a water pipe is designed to suit the cistern it serves. It would be unwise, for instance, to feed in wide roads stimulating much vehicular movement from suburban areas, if the central areas were not capable of accommodating the traffic. Conversely it would not be satisfactory to redevelop a town centre with large office blocks with huge car parks if the network could not deal adequately with the resulting traffic. This second example is one where technical consequences arising from the network, in spite of its service function, exercise a controlling influence over the capacity for traffic of the whole town. The main point, however, is that the concept of a network and areas puts highway capacity, and the capacity of buildings to generate traffic, into an understandable relationship on a calculable basis.



57 The basic spider's web plan with its strongly marked radial roads. The concept of 'ring roads' is derived from the idea of diverting traffic on the radial roads round the central area.

Characteristics of networks

104. *Pattern.* Over the last twenty years or so there has been much discussion and argument about the pattern best suited for the main traffic routes of towns. This discussion has been largely dominated by the idea of *ring roads*. Historically, most of our towns have developed with a strongly marked radial road system on a more or less symmetrical spider's-web plan. The town centre invariably lies at the centre of the web, but apart from this there may not in fact be any very marked symmetry about the disposition of the other main concentrations of activity. The central position of the business and commercial areas (usually the main traffic generators in the town), the radial road system, and probably the presence

† *Town Planning and Road Traffic*, H. Alker Tripp (Arnold, 1942).

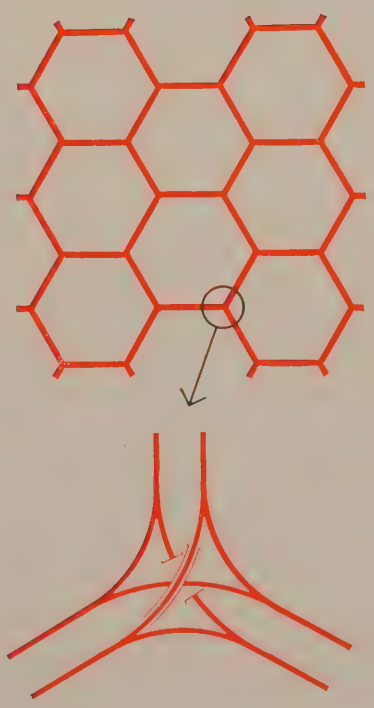
of through traffic which has no alternative route, have combined to produce heavy traffic flows on the radials. This has, understandably perhaps, led to the belief that the cause of central congestion is all the traffic pouring in on the radials, and that the obvious 'solution' is to divert the traffic round the centre. If the idea of diverting each radial is pursued there very quickly results a complete ring. This is the basis on which the familiar 'inner ring roads' came into being. The *intermediate* and *outer* rings of the post-war plans were partly inspired by the same desire to give relief to the centre, but also by the supposition that some kind of outer circumferential routes were useful to connect outer districts. Thus there emerged, by intuition more than by study of actual traffic drifts, the ring road concept and the general idea that this would provide the solution to the main traffic problem. There was an environmental aspect to this proposition as well, because the rings, especially the inner rings, were seen as providing 'relief' to the centre where congestion was at its worst. But there has been no attempt to define 'relief', nor to set up standards whereby it can be judged whether the relief given is likely to be worth having.

105. In some cases it appears that ring roads have been intuitively adopted in the first instance as part of the plan, and at a later date 'origin-and-destination' surveys have been taken to demonstrate that they would carry enough traffic to justify their construction. The results of such surveys are nearly always favourable to the ring road, for the simple reason that practically any new road cut through a densely developed area will, as a drain cut across a sodden field fills with water, attract enough vehicles to justify its existence in terms of flow. But if a wider view is taken the actual contribution to relieving the centre is extremely uncertain.

106. It is not being inferred here that a ring road is in no circumstances likely to form part of an urban network. The objection that is taken is against the slavish adoption of the ring as a standardised pattern. If the problem is considered in terms of a network serving environmental areas (a corridor serving rooms, to use the analogy with buildings) it will be seen at once that the pattern of the network must depend on the disposition of the areas, the kinds and quantities of traffic they generate, the associations that exist between one area and another, or between areas and the outside world. The pattern may eventually comprise a ring, but it must be allowed to 'work itself out'. In designing the network it is unnecessary, and indeed inadvisable to start with any preconceived intuitive ideas for ring roads, tangential roads, relief roads, internal by-passes, spine roads and the like. All these notions confuse the essential technical issue which is simply the distribution of traffic to areas of buildings.

107. The only circumstances in which a distributory network would be likely to take on a regular geometrical form would be in the case of an extensive area with a uniform spread of development. In such a case the network would be superimposed in the manner of a 'grid' with a definite pattern and 'module'. A hexagonal pattern (Figure 58) is very efficient, with economical three-way intersections, but other polygonal patterns are possible. A rectangular pattern tends to require very complex intersections. The basic dimension or 'module' of the distributory system in such circumstances will broadly depend upon the kinds and intensities of land uses within the enclosed areas: the more intense the activities, the more traffic will be generated, and so the greater will be the need to insert distributors, and thus the closer will need to be the mesh of the distributory system. Unfortunately the more intense the activities are, the more intense the development is and the more difficult it becomes to insert a proper distributory system.

108. *The need for a hierarchy of distributors.* The function of the distributory network is to canalise the longer movements from locality to locality. The links of the network should therefore be designed for swift, efficient movement. This means that they cannot also be used for giving direct access to buildings, nor even to minor roads serving the buildings, because the consequent frequency of the junctions would give rise to traffic dangers



58 The hexagonal network pattern which gives a good distribution with comparatively simple intersections.

59 The principle of the hierarchy of distributors. Access roads are not shown.

and disturb the efficiency of the road. It is therefore necessary to introduce the idea of a 'hierarchy' of distributors, whereby important distributors feed down through distributors of lesser category to the minor roads which give access to the buildings. The system may be likened to the trunk, limbs, branches, and finally the twigs (corresponding to the access roads) of a tree (Figure 59). Basically, however, there are only two *kinds* of roads—*distributors* designed for movement, and *access roads* to serve the buildings.

109. The number of stages required in a distributory hierarchy will depend upon the size and arrangement of the town. For the purpose of nomenclature we think it is preferable to refer to the main network of any town as the *town* or *primary* network. This may then be broken down into *district* and *local* distributor systems as the conditions demand, and in the 'opposite direction' it may have to link to regional or even national networks. Thus a primary network for a town of 10,000 population would be likely to be less powerful in character than in the case of a town of 500,000 population, but in both cases the function would be to effect the primary distribution over the town. We think this comparatively simple nomenclature could with advantage replace the present large number of terms—arterial roads, through roads, expressways, freeways, principal traffic roads, collector roads, service roads etc.—which are freely used with little if any standardisation of meaning.

110. There is, however, a value in terms which express the *standard* to which a road is designed. Thus in many cases the links of a primary network as envisaged here would carry sufficient traffic to justify their being reserved for motor traffic only, with fly-over type intersections throughout. This is the specification which has come to be known in this country as a 'motorway'. We do ourselves, at a later stage in this report, refer to the need for certain distributors to be built to 'motorway standards' purely as a result of the volume of traffic they have to carry. A distributor built to this standard and situated within an urban area could be called an 'urban motorway'. There is no objection to this term as long as it is realised that the function of the road is to distribute traffic, and that 'urban motorways' do not, as many people seem to think, possess some magical property.

111. *The importance of the details.* It is not difficult to devise distributory systems which seem satisfactory at the sketch map stage. The trouble starts when the details are worked out and the great width of the roads and the complexity of the intersections become apparent. This is considered in more detail in examples in the next chapter, but it can be said now that the sheer difficulty of inserting these roads into our cities, except in the simplest form, may well place a limit on the amount of motor traffic that can be accommodated. It is not a matter of engineering difficulties so much as the great amount of land required, the displacement of people and properties which is involved, and the severance and disruption caused by wide roads and big intersections. These effects can be studied in American cities, and the difficulties are manifest. Further reference to this aspect will be found in the section dealing with American practice in Chapter IV.

112. The very real possibility has to be faced therefore that practical difficulties of contriving the network could, and almost certainly will, limit the amount of traffic acceptable in urban areas. How these limits stand in relation to the desires of the public, and the consequences if the two are out of balance, is explored in more detail in the next chapter.

Characteristics of environmental areas

113. The idea of the network is comparatively easy to understand, but the concept of environmental areas is more difficult. These are the 'rooms' of the town; they are the areas or groups of buildings and other development in which daily life is carried on, and where, as a consequence, it is logical that the maintenance of a good environment is of great importance. The term 'precinct' (a long-standing term in town planning) cannot be used

for these areas because it now connotes the idea of a place that is entirely free from motor traffic. It cannot be emphasised too strongly that the environmental areas envisaged here may be busy areas in which there is a considerable amount of traffic, but there is no extraneous traffic, no drifts of traffic filtering through without business in the area. Any kind of development—residential, industrial, commercial, etc. or even mixed uses —can form an environmental area, but naturally the environmental standards will vary according to the kind of area, just as they vary between, say, the kitchen of a house and the bedrooms. Safety will be an overriding consideration in all kinds of area, but, to give an example, much more importance would be attached to freedom from noise in a residential than in an industrial area.

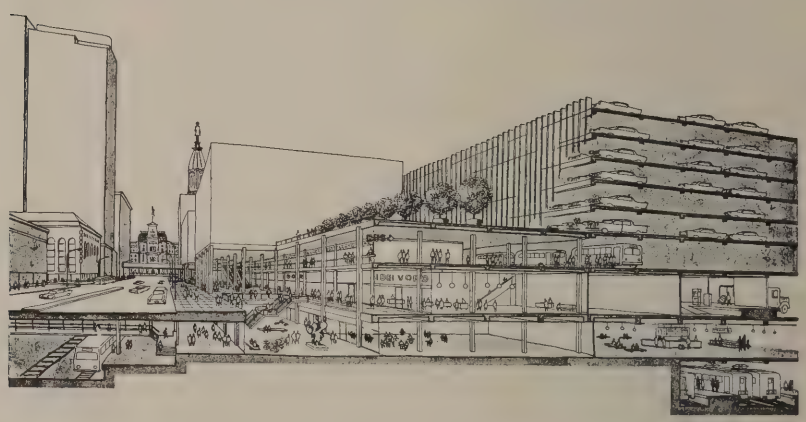
114. *Size.* The maximum size of an environmental area is governed by the need to prevent its own traffic building up to a volume that in effect necessitates sub-division by the insertion of a further distributory link in the network. Size is considered in more detail later on in this study, but it should be said here that no sociological content is implied by our concept of environmental areas. There is no connection for example with the idea of 'neighbourhoods', the concept is no more and no less than a method of arranging buildings for motor traffic. In fact, a neighbourhood of 10,000 people, which was the unit size postulated in the County of London Plan, would certainly require subdivision into a number of environmental areas.

115. The idea that within an environmental area the traffic (using the term, of course, to include stationary as well as moving vehicles as defined at the beginning of this chapter) should be subordinated to the environment carries with it the important implication that any environmental area must have a maximum acceptable level of traffic. It must, in other words, have a maximum capacity. This may be seen by considering the case of an area of terraced houses in conventional streets with narrow pavements. The amount of traffic within such an area would obviously have to be curtailed if reasonable standards of environment were to be secured. The acceptable amount of traffic should, in theory, be calculable. In order to ensure that it is not exceeded it might be sufficient (assuming it is an environmental area in the making) merely to exclude all extraneous vehicles, but even then the area's own traffic might increase beyond the limit as a result, say, of the conversion of the houses to flats, or as a result of an unexpectedly high car ownership rate. In this event there would either have to be a regrettable lowering of the environmental standards, or a curtailment of the accessibility. But there would also be the possibility of making, *at a price*, physical alterations to the area, for example by providing garages for cars which would otherwise be left on the street, or perhaps rearranging the area altogether by rebuilding.

116. *Three variables.* So, with respect to any environmental area, the traffic problem can be approached in terms of three main variables—the standard of environment, the level of accessibility and the cost that can be incurred on physical alterations. These can be related in a rough and ready 'law'. It is that *within any urban area as it stands the establishment of environmental standards automatically determines the accessibility, but the latter can be increased according to the amount of money that can be spent on physical alterations.* In plain words this means that if it is indeed desired to have a great deal of traffic in urban areas in decent conditions it is likely to cost a great deal of money to make the necessary alterations. The idea that any urban area, as it stands, has a definable traffic capacity if the environment is to be secured, is very important. There is really nothing strange about it. A factory is designed for so much plant and so many operatives; a school is designed for so many children; a house will hold so many occupants and if more are crammed into it, it becomes a slum. There is some elasticity in capacity, but not much. All that is being said here is that exactly the same kind of rule must apply to an area occupied by buildings and the amount of traffic it can decently contain.

117. The capacity of an environmental area to accept vehicles moving and at rest depends largely on the way the buildings and access ways are arranged. The example has already been given of a residential area with narrow conventional streets, which would have a low capacity. Another example would be a complex of conventional shopping streets with show windows facing pavements in the usual way—an arrangement which still works fairly well provided there is very little traffic. In both cases it would be possible to re-arrange the accommodation in ways that would enable many more vehicles to come in and yet give an equally good or perhaps much better environment. In the case of the shopping area, for example, the shops could be re-arranged so as to front on to squares or streets reserved for pedestrians only, with the vehicular access for goods vehicles and parking at the rear. Or there could be parking on roof tops, or there might be a central multi-level traffic core with the accommodation set out to the flanks.

118. *Traffic architecture.* There is a new and largely unexplored field of design here, but it involves abandoning the idea that urban areas must necessarily consist of buildings set along vehicular streets, with one design for the buildings and another for the streets. This is only a convention. If buildings and access ways are thought of *together*, as constituting the basic material of cities, then they can be moulded and combined in all sorts of ways many of which are more advantageous than the conventional street. A useful term with which to describe this process is 'traffic architecture' which conveys the idea of buildings and building groups being purpose-designed for the efficient handling of traffic.



60 Traffic architecture. '. . . buildings and access ways thought of together . . .' (Penn Center, Philadelphia).

119. Although traffic architecture techniques would involve a 'new look' for urban areas, in many ways it could still result in an 'old look' freed from the domination of the motor vehicle. To take an extreme but simplified case, the central area of a town might be redeveloped with traffic at ground level underneath a 'building deck'. This deck would, in effect, comprise a new ground level, and upon it the buildings would rise in a pattern related to but not dictated by the traffic below. On the deck it would be possible to re-create, in an even better form, the things that have delighted man for generations in towns—the snug, close, varied atmosphere, the narrow alleys, the contrasting open squares, the effects of light and shade, and the fountains and the sculpture. The deck would be so literally new ground that buildings could be erected upon it and in due course taken down and replaced, and sites could be sold or leased in the normal way.

120. The prospects must, however, be kept within bounds. There will be many places where there are buildings of historical or architectural value, squares, trees or pervading character which no one would wish to change. This does not rule out traffic architecture, but it makes it much more complicated. It means the intricate combination of the old and the new. There will be genuine precincts of older buildings at ground level merging into more complex multi-level arrangements. Here pedestrians will be down in normal streets with a minimum of traffic, there they will be up on a lacework of paths with views down to the traffic. Here vehicles will be

below ground, there they will be on the surface. The presence of existing buildings which cannot be redeveloped will unquestionably affect the amount of traffic that can be planned for. But environmentally they provide the challenge for the creation of urban areas of great variety and interest.

121. *The need for comprehensive redevelopment.* One point which is abundantly clear is that the traffic architecture techniques described here cannot be applied over small areas. It is essential to be able to command the development or redevelopment of sizeable areas. The creation, for example, of an elevated pedestrian environment obviously cannot be achieved in penny-packet instalments. This is the issue of 'comprehensive redevelopment' which raises so many controversial questions of procedure, finance, and the pooling and redeployment of ownerships. It would not be appropriate for us to deal with these in detail in this Report, but we do feel bound to say that unless answers to these questions are found, and unless the public accepts that there has to be comprehensive redevelopment over large areas, then the opportunities for dealing imaginatively with traffic will all be lost, and in the end this will severely restrict the use that can be made of motor vehicles in built-up areas. Even as this Report is being written the opportunities are slipping past, for in many places the old obsolete street patterns are being 'frozen' by piecemeal rebuildings, and will remain frozen for another half century, or longer.

122. *Residential areas.* Special mention needs to be made of the design of residential areas for traffic. The 'user requirements' may be set out as follows:

(i) Ideally people will want to bring their cars right up to their dwellings, and to garage them inside.
(ii) They will need space reasonably near the dwelling for visitors and tradesmen to park.
(iii) The layout of the area should be easy to comprehend so that residents can have a feeling of locality and visitors can find their way.
(iv) Residents will want to live in conditions of maximum safety and freedom from the nuisance of moving vehicles, and to be able to send their children out to play and to school with the minimum of risk.

123. The nearest these requirements have come to being completely satisfied is through what is now commonly known as the 'Radburn layout'. This idea was derived originally from English Garden City practice. It was exported across the Atlantic to be developed by Clarence Stein and Henry Wright at Radburn in New Jersey in 1928, but seems to have had singularly little influence on American practice. In recent years it has come back across the Atlantic with considerable effect on our own local authority and New Town housing.

124. The main principles of the Radburn system are:

(i) the creation of a superblock (or, as we would say, an environmental area) free from through traffic, and
(ii) the creation of a system of pedestrian footpaths entirely separate from vehicular routes, and linking together places generating pedestrian traffic.

125. The original Radburn idea is shown in Figure 61 and an example of a layout from Sheffield in Figure 62. The practical effect is that a house has access on one side to a service road or cul-de-sac, and on the other to the independent footpath system. This is in contrast to the conventional arrangement whereby pedestrians and vehicles approach on the same road. The need to apply the principles in full depends largely on the density of the development. Probably the reason why they have had comparatively little influence in the U.S.A. is that so much of the development is so low in density that there is not a great deal of walking around in any case, and what there is seems to be safeguarded by the comparatively mature and

61 The principle of Radburn planning.

62 The Radburn principle in practice. A layout from Sheffield.


2

considerate behaviour of car drivers. But with the higher residential densities that we are bound to have in this country, and with the greatly increased numbers of cars in the future, the principles are likely to become increasingly useful. The application of the principles does however involve comprehensive designing over sizeable areas. This is possible when the work is being done by local authorities or New Town corporations, but it is very difficult to secure better layouts from private developers with the conditions of piecemeal development in which so much private housing is done.

126. *Environmental Standards.* It is one thing to say that an area should be safe, free from noise, and generally agreeable, but quite another to define standards by which these qualities can be measured. Yet without standards it is difficult to reveal convincingly the state of affairs in any place, or to make comparisons. In quite a number of matters in town planning it seems that real progress has only been made when standards have been worked out and accepted, for then people have been able to see at once where things are wrong. We have been very much at a disadvantage because so little serious research has been carried out into environmental standards. The scale of the studies required was beyond anything we could become directly engaged in. We were aware of the dangers of proceeding without sufficient knowledge, but nevertheless we had to do our best to steer round the many imponderables. More is said in Chapter V about aspects that require further study, but meanwhile an indication can be given of the main factors involved.

127. To recapitulate, the several ways in which motor vehicles menace environment are through danger and intimidation, noise, fumes, vibration, severance, and visual intrusion. These effects are felt mainly by pedestrians and the occupants of buildings, though to varying degrees, but they may also be felt in part by the occupants of vehicles. They are largely experienced, of course, on account of the ubiquitous presence of the vehicular urban street, a form of development which now seems as though it were specially designed to produce these adverse effects. If we could get rid of such streets many of these problems would disappear. But we are likely to have them for a very long time, and much of the study of environmental standards must be concerned with the conditions under which the street can continue to play an effective role. It should not be difficult to form an objective judgment about some of the adverse effects of traffic in streets. If it were accepted, for example, as a standard, that people should be able to engage in normal conversation on the pavement without shouting then it should be possible to define an acceptable noise level from traffic. An acceptable level could in the same way be defined for the interior of buildings. Likewise an air pollution standard could be defined, and doubtless a standard for vibration could also be devised. It would then be possible in any street to secure these standards by regulating the number, speed or weight of the vehicles passing along. This much is comparatively simple. Danger, anxiety and intimidation, however, are far more difficult. *Absolute* safety for pedestrians could be secured only by preventing them crossing the carriageway on the level, and in some way excluding all possibility of a vehicle mounting the pavement. But if motor traffic in a street were to be progressively reduced in volume and speed there might come a point at which the risks to pedestrians were acceptable without physical alterations to the street. A number of other factors would influence the application of these standards—the width of the pavements, for example, and the functions of the buildings fronting the street, as well of course as the character of the traffic.

63 (*opposite*) An impression of the Radburn idea applied to a medium density residential area. The central square is wholly pedestrian. An access area for cars is shown in the foreground, and the bus route can be seen in the distance.

128. Even more difficult is the question of visual intrusion, because it is so much a matter of personal opinion. To someone interested in cars, for example, a historic square may seem a much more exciting place if it is used as a car park than if it is kept open. Yet the attitude we take to visual intrusion, or, to put it another way, the standards we choose with regard to it, is in many ways of crucial importance. The reason is that the space

demands of motor vehicles are potentially enormous, and if we decide that intrusion does not matter then we must be prepared to see an ever greater loosening of urban structure, with more and more space devoted to open parking, until eventually the greater part of the external visible environment of towns would be devoted to the motor vehicle and its needs and the establishments which depend primarily upon it. One can go to Los Angeles now, and many other American towns, and see what the results are like. Society will have to choose which course to take—the easy way based on the open parking lot, or the much more difficult course of either sacrificing some degree of accessibility or else undertaking extremely expensive works to accommodate the vehicle in a civilised way. As discussed previously, our assumption is that society, perhaps only after some bitter experience, will decide that visual intrusion is as deserving of the fixing of standards as are the more tangible aspects of danger, noise, fumes and vibration.

129. *Environmental capacity of streets.* All this suggests that with further knowledge it would be possible to take any existing street and after examination of its dimensions, the uses and character of the adjoining buildings, and the amounts of pedestrian traffic along and across it, to define the volume and character of the traffic permissible in the street consistent with the maintenance of good environmental conditions. This amount of traffic might be called the 'environmental capacity' and in all probability it would be much lower than the sheer number of vehicles that could be got along the street or that could be accommodated in parking spaces. This second figure might be called the 'crude capacity'. From this idea that an environmental capacity could be defined for a *street* and the adjacent buildings it serves, it is only a step to the possibility that both environmental and crude capacities could be evaluated for complexes of streets, or for whole environmental areas.*

130. It is often said that streets are for the *passage* of traffic only, and although this may be a sound legal view it has obscured the fact that streets perform other functions, some of them vital. They give access to buildings, they provide an outlook from buildings, they give light and air, they are the setting for architecture, and they are the backbone of the everyday surroundings for many people. It is impossible to maintain that these functions are subordinate to the passage of vehicles. As traffic increases in the future it seems inevitable that the assessment of environmental capacity will become of more and more significance. Already, in fact, it is the crucial issue in many streets. On what basis, for example, is it possible to begin planning the future of that famous street at Oxford, the High Street, other than by calculating its environmental capacity and then considering what steps are needed to reduce the traffic to that figure and *to prevent its being exceeded in the future*? Or, to take another example, what can now be done about Oxford Street, London (the opportunities for imaginative redevelopment having been largely missed already) other than to accept it as a major shopping street, to calculate its environmental capacity, and to take steps to bring the traffic down to the appropriate figure and to stabilise it there?

131. It is being seriously suggested here that the time is fast approaching when hundreds of streets in hundreds of towns and villages, will have to be classified for their primary function, and if it is an environmental function (e.g. shopping, residential) then the yard-stick for all planning and improvement works must be the environmental capacity. Otherwise streets will steadily become more unpleasant, and people will begin to forsake them for places where comprehensive development has been undertaken and far better conditions are offered. To make our standpoint clear beyond any doubt, we do seriously invite the reader to consider the example of Oxford Street, London, and to conclude that what is now emerging in that street is a travesty of conditions as they ought to be in a great capital city (Figure 64).

* Possible methods of measuring these capacities are discussed in Appendices 1 and 2.

132. In some streets the reduction of the traffic to match the environmental capacity could be achieved by squeezing out all the extraneous traffic with no business in the street, but in others the environmental capacity might be so low as to prevent the entry even of traffic essential to the functioning of the buildings along the street. In these cases other measures would have to be resorted to, e.g. the entry of service vehicles after hours, or the provision of new loading facilities at the back or side of buildings. But the important point is that the estimation of environmental capacity provides an immediate pointer to the policy to be adopted for the street. Only in this way is it possible to answer the person who says, reasonably enough, 'The conditions in this street would be quite acceptable if there were not so much traffic.' The person who says this is in fact expressing a view on the environmental capacity, and seeking the application of an environmental standard.

133. *Pedestrians and vehicles.* There are three main groups of people whose environment needs to be protected by these standards:

(i) People within buildings.
(ii) People outside buildings (people sitting about, children at play, etc.).
(iii) Pedestrians, either ambling about for a great variety of purposes, or acting in their role as part of the transport system.

Clearly it is the people in the second and third groups, but particularly the pedestrians, who are most immediately in contact and at risk with vehicles. The standards which directly influence the relationship between pedestrians and motor vehicles may therefore be claimed to deserve the most weight.

134. It is tempting to say that the objective should be the complete separation of pedestrians and vehicles in all circumstances. In one sense such a standpoint would simplify matters considerably. When applied to London's Bond Street, for example, which obviously is a shopping street where environmental needs ought to come before everything else, it would follow that the street should be closed to vehicular traffic and pedestrians be given the free run of it. This approach would offer a clear-cut decision, a firm position from which to work outwards, and it would be perfectly clear that some alternative route for the vehicles would have to be found, no matter how complicated or expensive. But there are difficulties about laying down complete separation as the desirable standard, the principal of which is that there does not seem to be the slightest chance of ever achieving it universally, nor is it obvious that it would be worth pursuing it universally. The fact seems to be that, up to a point, a mixture of pedestrians and vehicles is not seriously harmful. A visitor to America, for example, whatever he may feel about visual intrusion, cannot fail to be impressed by the way many residential areas

64 Oxford Street, '. . . a travesty of conditions as they ought to be in a great capital city'.

(admittedly of low density) function reasonably satisfactorily without any special provision for pedestrians. That this is possible is largely a result of the mature standards of driving which have been achieved.

135. Nevertheless, as far as shopping and business areas are concerned, there is a growing volume of evidence from all over the world of the advantages of these activities being undertaken in a completely traffic-free atmosphere.

Conclusion

136. The approach adopted in this study differentiates it in three main respects from most previous studies:

(i) In most other studies the traffic problem has been seen primarily as one of keeping vehicles on the move. As a result, these studies have been concerned first with by-passes to towns and have then worked *inwards* towards the town centre, applying the by-pass principle to facilitate the passage of vehicles round congested shopping centres and bottlenecks. This concentration of attention on the movement of vehicles has tended, we think, to distort or obscure the basic environmental objectives of town planning. The approach adopted in this study, centred on an attempt to distinguish the basic values, produces an inwards-outwards progression. Attention is first turned to the environment, to delineating the areas within which life is led and activities conducted. Gradually, for the whole town, working *outwards* from a large number of points, the cellular structure takes shape, and as it does so, by a complementary process, the pattern of the network declares itself. This, we submit, is the right order, and thus are vehicles and the arrangements for their movement kept in the right place—the place of service, no more, to the buildings and the activities therein.

(ii) The approach we have outlined opens the possibility of objective, quantitative assessments in fields where hitherto much has depended upon intuition.

(iii) Traffic is seen as part of the comprehensive problem of town planning. The importance of this for the redevelopment of urban areas, for administration, and for collaboration between the professions can hardly be exaggerated.

Chapter III: Practical studies

137. As explained at the beginning of the previous chapter, we arrived at our working theory by a combined process of searching for principles and studying actual cases. The time and resources at our disposal enabled us to carry out only four major studies. We chose these carefully in order to gain as much knowledge as possible. First we examined the problems of a small town, treating it as a pilot study to bring us to grips with our subject. This completed, we turned our attention to a much bigger town with a population of half a million. Thirdly, we looked into the special problems of a historic town. Fourthly, we studied a portion of Central London, perceiving that this would not only bring us up against most of the problems of redevelopment and urban form, but might also provide a short-cut to an understanding of traffic problems in a very large urban area. We also carried out various minor investigations to clear up specific points, and, of course, we examined a great many plans, projects and completed works in this country and abroad. A special visit was paid to the United States to assess practice there. Our own studies are described in this chapter, and our review of current practice in the next.

138. We decided the best way to present this material was roughly in the order in which we used it to develop our thoughts, starting with the pilot study of a small town, and working up to the problems of bigger towns. We do not think any useful purpose would be served by attempting to disguise the localities we studied ourselves, but it should be understood that the exercises are purely academic, and have not been made with any idea of suggesting to the particular local planning authorities how their own areas should be planned. The help we received from the local authorities is acknowledged separately in each study; but we record here our appreciation of the general assistance given by the Traders Road Transport Association who arranged many contacts with firms, as a result of which we were able to learn much about commercial and industrial traffic.

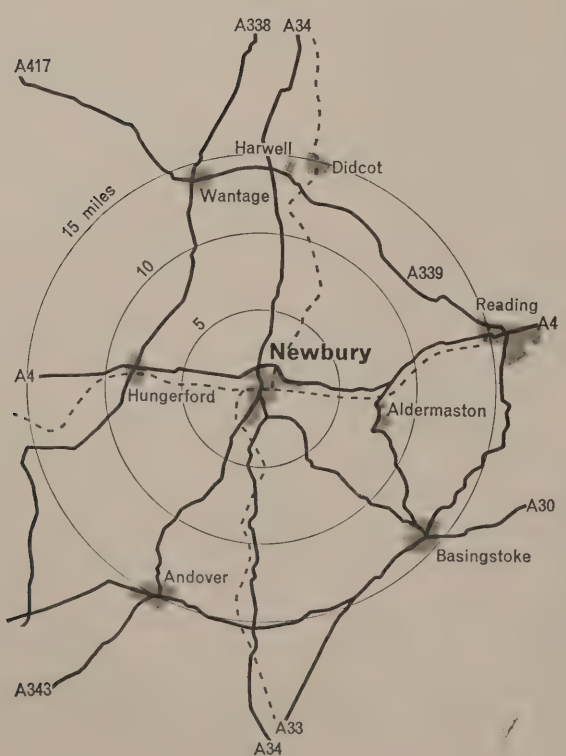
139. We must emphasise that in the working examples discussed in this chapter, it is the way in which the problems are approached that is much more important than any quantitative conclusions reached. We think some reliance can be placed on the figures as indicating the range of possibilities; but when the reader follows the examples through he will realise that we have made no more than a modest beginning in getting this complex subject, with its mass of imponderables and alternatives, onto a reliably calculable basis. Add to this the fact that no special surveys were possible in the time available to us, and that in respect of various matters virtually no basic research data is available in this country, and it will be appreciated that this is a field in which a great deal of work remains to be done. We were also limited by lack of time and resources in what we could do to estimate the costs of various courses of action. For two reasons this may not be a serious deficiency. First, it is quite evident that if the growth of traffic is to be accommodated it will require expenditure on a new scale altogether, so precise estimates in today's terms are not necessarily very relevant. Secondly, sheer figures of cost can be seriously intimidating, even misleading, unless accompanied by a comparable statement of benefits. This, of course, is the complex field of cost-benefit analysis, to which we attempt a simple introduction in Appendix 2.

Part One: A small town

140. We decided to look first at a small town where the issues would not be too complicated. Various factors affected the choice of a town, not the least being the need to find a place where some survey data existed. We finally chose Newbury in Berkshire. The objectives of the study were to reveal the effects of a build-up of vehicle ownership and usage to the maximum foreseeable level, and to ascertain the kind and scale of measures needed to deal with the resulting situation. We quickly found that for an exercise of this kind we needed much more information than was in fact available, and being unable ourselves to conduct any elaborate surveys we were forced to make a great many assumptions. We worked within the local planning authority's proposals for the future size and activities of the town, but we deliberately disregarded all current proposals relating to highways and redevelopment. We also put out of our minds all preconceived ideas on the pattern roads might take, such as ring roads or relief roads. We sought to estimate as accurately as we could the various ways in which people seek to use vehicles, and to see what such usage would involve. In the following paragraphs we describe, as far as possible in non-technical language, the steps of our analysis. In practice it involved many long and laborious calculations.

141. We are grateful to the County Planning Officer of Berkshire and his staff, and the Borough Surveyor of Newbury, for allowing us to have access to survey data.

65 General location of Newbury.



66 The environs of Newbury, with distances. Railways indicated by broken lines.

Present conditions

Situation of Newbury

142. Newbury lies 17 miles west of Reading at the intersection of the London–Bath Road (A.4) and the Southampton–Birmingham Road (A.34). It is a market town of about 30,000 population with the usual range of activities of such a town (see Figure 72). It serves as a centre for the surrounding rural area, and it is estimated that the additional population dependent upon it is about 30,000. At Thatcham, a few miles to the east, there is a group of paper mills, and the atomic energy research establishments at Aldermaston and Harwell are two other employment centres which have a considerable influence on the pattern of movement.

The main movements

143. The present-day movements connected with the activities of the town may be classified as follows:

Journeys between homes and work places,
Journeys between homes and schools,
Journeys for shopping purposes,
Journeys in connection with social and recreational activities,
Service journeys for professional purposes, by public utility undertakers, property maintenance men, etc.,
Transport of supplies to and from wholesalers, retailers and manufacturing establishments.

The work journeys

144. Observation suggests that Newbury is no different from most other towns in that the dominating movements during the periods of the heaviest traffic flows are the journeys to and from work in the morning and evening, and so we concentrated our attention upon these in the first instance. Without making an elaborate survey (which at the least would have involved a sample survey of the population, requiring several thousand interviews), we had to establish the origins and destinations of all the work-journeys. To assist in this process we first divided the whole town and its dependent hinterland into a number of well defined sub-zones of residence and employment. With the help of statistics from the local planning

authority, from the Ministries of Labour and National Insurance, and from the local rating assessments, we were able to establish the number of workers living in each residential zone, to classify them into income groups, and to make a series of assumptions as to where the people worked. This could not, of course, give completely accurate results, but we were satisfied that it gave us a fairly reliable indication of the main corridors of movement.

145. These corridors of movement are illustrated in the desire line diagram shown in Figure 73. This diagram reveals the complex journey pattern that arises twice each working day at the present time.

Mode of travel

146. Thus far we had obtained a picture of *movements*, but without regard to the means or 'mode' of travel nor the period over which they take place. From an examination of the variation in present-day flows, it was apparent that the majority of the work-to-home journeys took place during the period from 5 p.m. to 6 p.m., with a distinct peak between 5.00 and 5.15 p.m. We then examined the number of car and motor cycle registrations in Newbury and district, and arrived at a ratio of cars per 1,000 persons

67 Aerial view of Newbury, looking north. Northbrook Street runs northwards from the bridge over the Kennet, which is in the middle distance near the church.

68 Heavy through traffic in the town centre.

69 Northbrook Street—lack of unloading facilities adds to the problem.

70 The narrow bridge over the River Kennet at the southern end of Northbrook Street. This is part of a trunk route for long distance traffic.

for each of the various residential zones, the ratios being adjusted in accordance with the distribution of the income groups. We also examined the availability of public transport in various localities, and the position of the residential zones in relation to the employment zones. In this way we were able to make an estimate of the manner in which the various work-journey movements would be apportioned between buses, private cars and motor cycles, pedal cycles, and pedestrians. Figure 74 shows the estimated proportion of workers travelling by each of the various modes of travel from each residential zone.

Peak hour flows

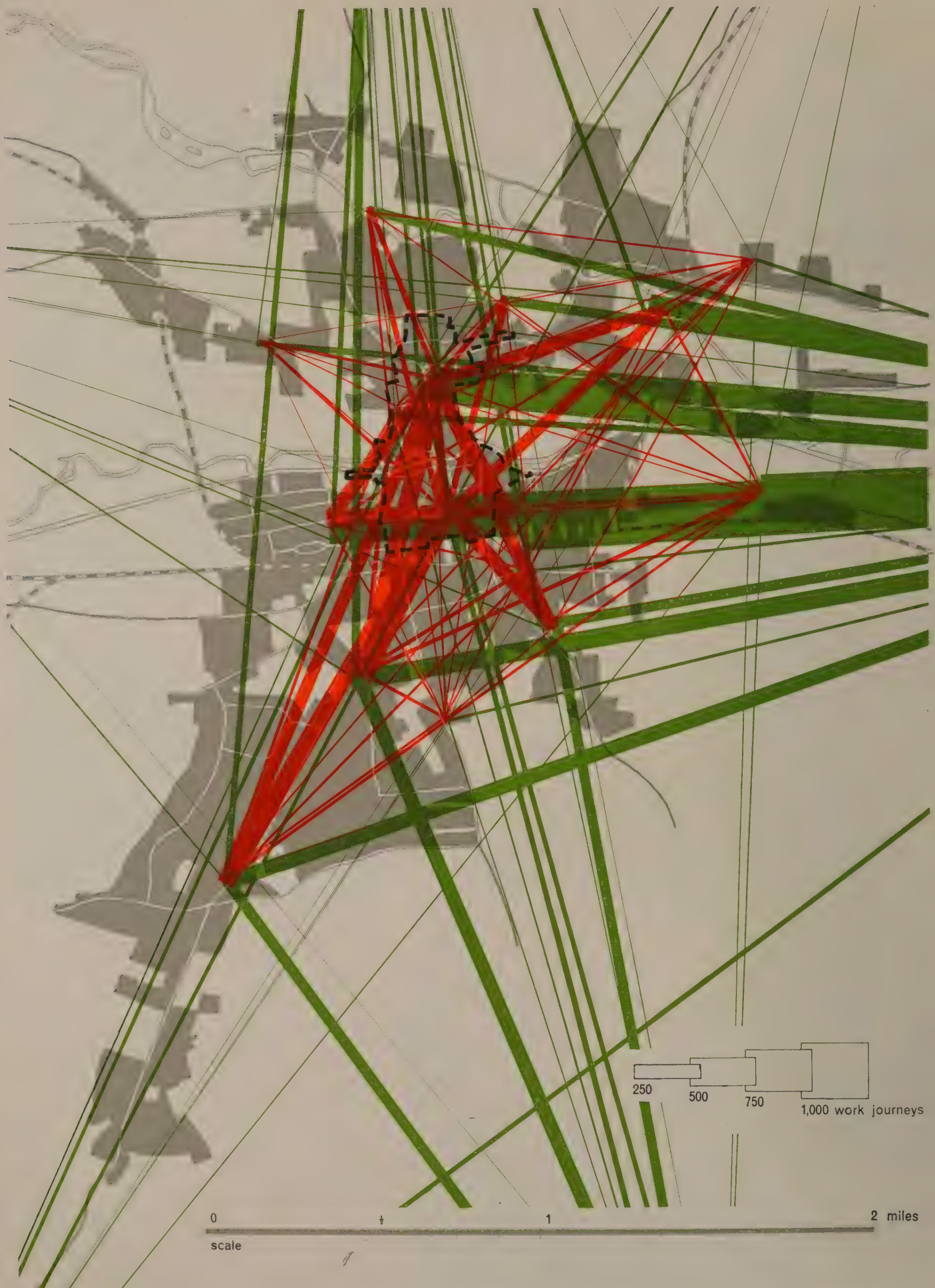
147. A hypothetical picture could then be drawn of the flow of vehicles along the existing main road system for a normal weekday at the *peak hour*. The peak hour is that period of one hour during the 24-hour day in which more traffic is carried than in any other hour. We had worked out the figures for the work-journeys which we knew would be dominant in the 24-hour picture. By assigning each group of movements to the most likely route between the various origins and destinations, we were able by a process of summation, wherever such movements coincided, to determine the probable volume of work-journey traffic on each section of road. An assumption was made that the additional traffic consisting of commercial vehicles, buses, and cars used for other non-work journeys, would amount to roughly 10–25% of the work-journey flows, depending on the character of the route. In and around the town centre, where shopping and commercial traffic is particularly important, we refined the calculations for commercial traffic by using a traffic generation factor of the number of vehicles per 1,000 sq. ft. of floor area, the factor varying for different types of land use. We also found that detailed figures were available from a recent survey of *through traffic*. Putting all this information together we secured the picture of peak hour flows represented in Figure 75. We checked the total flows by means of a number of actual spot counts, and made any necessary adjustments. A few such adjustments were necessary, but generally the estimated flows were sufficiently close to the actual flows to indicate that the method of analysis was sound, and that the assumption as to the period over which the majority of journeys took place was correct.

Accessibility

148. We then examined the existing system of roads along which all this traffic has to pass, in order to check its efficiency for providing convenient movement between the various parts of the town, and for giving access to individual premises. We found a good deal of congestion, lack of parking and garaging facilities, inadequate loading facilities, restrictive traffic regulations, and in places a definite conflict arising from the use of particular roads for different kinds of traffic. As might be expected these difficulties were most severe round the town centre and in the more central residential areas (Figure 76).

71 The Broadway, looking south along Northbrook Street. A busy congested shopping street which also carries through traffic on the trunk road A.34.

72. Newbury. The main land uses.



73 Desire line diagram for all work journeys. Journeys lying within the borough shown in red, journeys with origin or destination outside the borough are in green.

74 Present day mode of travel for the journey to work from each residential zone including residential zones outside the city (indicated by arrows).

75 The present-day peak hour traffic flows.

76 Survey of the present problems of *accessibility* in Newbury.

Environment

149. We then examined the clash between traffic and *environment*. We found roads where the volume of traffic was clearly incompatible with pedestrian safety, places where pavements were extremely narrow, areas of closely associated uses which were severed by busy traffic roads, roads where the traffic created a severe noise nuisance, and places where the visual scene was unpleasantly disrupted by both moving and stopping traffic.

Future increase of traffic

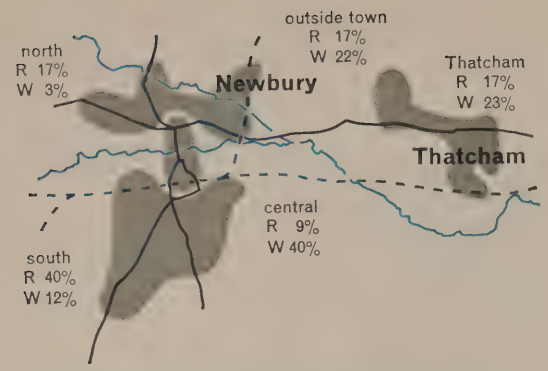
150. We next turned our attention to the future load which the network would have to carry. For this purpose we assumed that vehicle ownership would be approaching the maximum soon after the turn of the century. We also assumed, taking the County Development Plan as a guide, that the population of the built-up area of Newbury and Thatcham would increase to about 37,000 and that the dependent rural population would remain at about its present figure of 30,000. The development plan proposes no drastic changes in the areas or dispositions of homes and workplaces, so we concluded that the desire lines for the year 2010 would not be greatly different in their *directions* from those shown in Figure 73, but it was obvious that the number of journeys was likely to be dramatically increased.

151. The load which a network has to carry varies in intensity throughout the day. But, as pointed out previously, there are two periods in most towns in the morning and evening respectively, when loads are concentrated, and this is primarily due to the traffic associated with work-journeys. These periods we refer to in this report as the *peak period*.* The duration of a peak period depends on a number of factors including the overlap that exists between the times at which firms commence or finish work, the relative location of homes and workplaces, and the existence of a state of congestion which may force or encourage a lengthening of the period. In general, in small towns, the peak period tends to be short, perhaps no more than ½ hour, but in larger towns it may extend up to 2 hours or even longer. As a rule the evening peak is more concentrated than the morning peak. To be successful, a network must be able to discharge efficiently the traffic that arises during these peak periods. As far as Newbury is concerned, we have assumed that the desire will remain for the great majority of all work-journeys to take place within a period of one hour. It may be objected that it is extravagant to design for a peak period when there is the alternative of hours of work being deliberately staggered so as to spread the load, but we are inclined to doubt whether there is much chance of any more drastic staggering of hours being acceptable to the public than obtains at present. Indeed, as the standard of living rises, the demand is likely to be increasingly for normal hours of daytime work for as many people as possible. By this reasoning, peak periods are likely to be a permanent feature of life which have to be accepted and designed for. At all events it was the express purpose of this exercise to study the implications of the full use of vehicles without restrictions such as enforced staggering of hours.

152. We estimated that the number of cars used for the work journey would rise (given an adequate network and suitable parking places) from about 3,000 to nearly 9,000 (a 200% increase) while the total number of persons travelling to work by all forms of transport would increase only by about 28%. Figure 77 shows the number of journeys from each residential zone, and the main modes of travel likely to be adopted in 2010. This can be compared with the existing modes of travel shown in Figure 74. We did not construct a peak hour flow diagram for the year 2010 on the basis of the *existing* street system because it was quite obvious that the existing system could not possibly carry the enormously increased loads.

* *Peak period* is to be distinguished from *peak hour* which is defined in para. 147. *The peak hour* load is the basis for the technical design of a road system. Peak hours naturally tend to occur during peak periods.

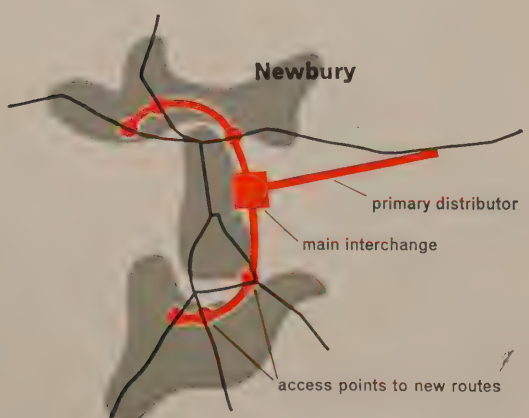
77 Mode of travel for the journey to work from each residential zone in year 2010 including residential zones outside the city (indicated by arrows).



78 The main zones of traffic generation, showing the percentage of all workers resident in each zone (R), and the percentage of all workers employed in each zone (W).

79 The main desires for movement at the evening peak period. The heavier movements are indicated by the larger arrows.

80 Lengths of existing main roads already overloaded or otherwise unsatisfactory (dotted sections).



81 The basic form of the new network.

We do not think there is any doubt about this at all. The potential build-up of traffic, as vehicle ownership increases, is far beyond anything that could be accommodated by any adaptations of the existing road system. It is not only that the widths and intersections of the existing road system are inadequate, it is the mixture of functions that the roads are called upon to discharge that is an equally serious difficulty. At this point, of course, we might have taken fright, and decided that the restriction of traffic was the only course open, but this would have been contrary to the brief we set ourselves, of demonstrating what is involved in going the whole way with the motor vehicle.

The primary network

Basis of design

153. We could see that what was needed was a new primary network, so we considered the principles on which it should be planned. First we assumed that through traffic now using the A.4 and A.34 trunk roads would be removed by the provision of suitable by-passes. The location of the by-passes was outside the scope of our study, but we noted that in the County Development Plan it is the projected South Wales Motorway that will in fact act as the by-pass for the A.4 route. The line of this lies a fair distance to the north of Newbury, so we did not consider that it could be relied upon to by-pass all the through-traffic, and we made some allowance for this in our estimates. It might be asked whether the provision of these by-passes would be a 'solution' to Newbury's problems. The answer to this question is that if the by-passes could be built *now* they would certainly bring a measure of relief. But it would only be a temporary relief, for our study showed that as vehicle numbers increase in the future it is the build-up of *town traffic* that becomes the really formidable problem to cope with.

154. The basis for the design of the new network is shown in the sequence of diagrams in Figures 78–85. The first diagram shows the relative positions of the main traffic generators—the residential and employment zones. The second diagram shows the directions of the main movement-desires. The third shows which of the main town routes are already unsatisfactory. The fourth diagram shows the basic form of a new network that would serve the movements, and the remaining diagrams show the progressive refinements which are necessary to blend such a network into the particular situation at Newbury.

Environmental areas

155. Having thus obtained a *general* idea of the plan of the new network we turned to consider the environment of Newbury. The problem is to distribute traffic to all parts while maintaining or regaining a satisfactory level of environment. We made a careful study of the *whole* of the town, and endeavoured to delineate the areas which should not, because of their layout arrangement, use, or character, be severed by main traffic flows or be subject to cross-filtration. In this we took account of local shops, local schools, and particularly the journey to school for younger children. We also considered the question of pedestrian movements, because clearly in a small town such as Newbury walking plays an important part in the transport system, particularly for journeys to the centre from the nearby residential areas. We found certain pedestrian movements to the town centre which, because of their number or character, seemed to require the provision of special routes (Figure 86).

Cyclists

156. We also considered the question of cyclists. Although in the 'mode of travel' diagram for the year 2010 (Figure 77) there is an allocation of movements to pedal cycles, it must be admitted that it is a moot point how many cyclists there will be in 2010. In the United States the bicycle seems

to play only a minor role, but we are inclined to think that it may well be retained in the more closely-developed conditions in this country, though probably in diminished numbers. The point does not greatly affect the amount of vehicular traffic for which the new network has to be designed, but it does affect the kind of roads to be provided. On this point we have no doubt at all that cyclists should not be admitted to primary networks, for obvious reasons of safety and the free flow of vehicular traffic. It would make the design of these roads far too complicated to build 'cycle tracks' into them, nor would this be likely to provide routes convenient for cyclists in any case. It would be very expensive, and probably impracticable, to build a completely separate system of tracks for cyclists.

157. In the conditions that are likely to arise in the future, as vehicular traffic grows, we are inclined to think that it will become necessary to divert cycle traffic increasingly to the less busy roads. In many instances it may even be desirable to allow cyclists and pedestrians to use the same route, suitably sub-divided, especially at critical points where cycle and pedestrian routes cross over or under main distributors. After all, as far as vulnerability to motor traffic is concerned, pedal cyclists and pedestrians have a great deal in common.

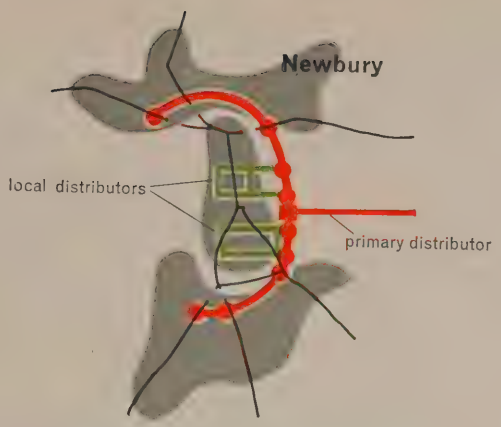
Radial roads

158. We found that a particular environmental difficulty arose (and it is one that is common to all our towns) on the main radial roads. In the residential areas, these roads not only serve to give direct access to the dwellings, but also function as local distributors linking with numbers of access roads. In the absence of any alternative route there is the added complication that through traffic has to make use of the radials. Even if the through traffic is discounted, the volume of traffic in 2010 would build up along the radials approaching the town centre, as flows from the tributary roads came in, until the traffic level would become incompatible with the residential function of the road. A decision had to be taken, therefore, whether to direct traffic away from the radial, or to convert the radial into a distributor. The second course would necessitate the elimination of direct access to frontage properties, and would involve rearrangement or regrouping of environmental areas. This point is illustrated in practice in Figure 88, in which it can be seen that road A.343, south of the town, is diverted to the east at a point where the volume of traffic becomes incompatible with the function of the road as a residential access road.

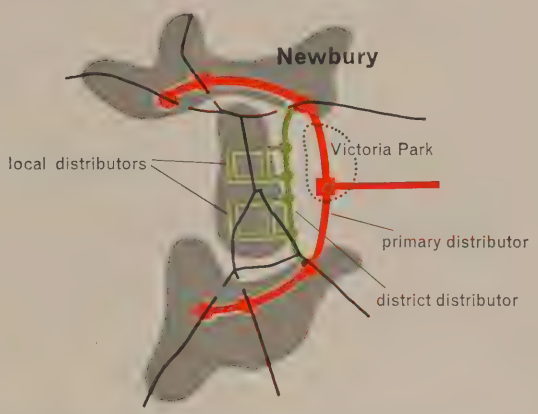
The new network

159. We thus gradually built up a tentative pattern of environmental areas for the whole town (Figure 87), and then we amalgamated this with the provisional road network to produce the overall arrangement shown in Figure 88. The new roads of the network were not thought of as 'relief roads' for the town centre. They represent a more positive concept than that. They provide a new system for distributing traffic to the various parts of the town. They involve a considerable disciplining of movement. Drivers would, for example, find themselves with little choice of route, the layout of roads would prevent cross-filtration and short-cuts through residential areas. But to compensate for this there would be the facility of roads designed expressly for movement.

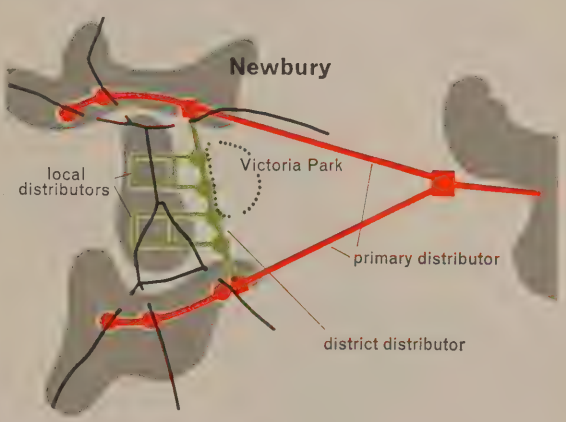
160. To enable the network to be designed in more detail, a peak hour flow diagram was then constructed for the new network. This is shown in Figure 89, and when compared with Figure 75 it gives a good idea of the very substantial nature of the traffic flows at the turn of the century. From this we were able to work out the widths of the new roads and the layout of the intersections (Figure 88). The really important point to note is that high standard roads are involved, with the need for at least one two-level intersection. We are confident we have not exaggerated this, and that this is the scale of construction required in a town of 37,000 population, with a surrounding population of about the same size, if full use of motor vehicles is to be made possible.



82 The basic network further developed with local distributors to serve the central area. But the north-south section of the primary distributor has to serve as a district distributor as well.

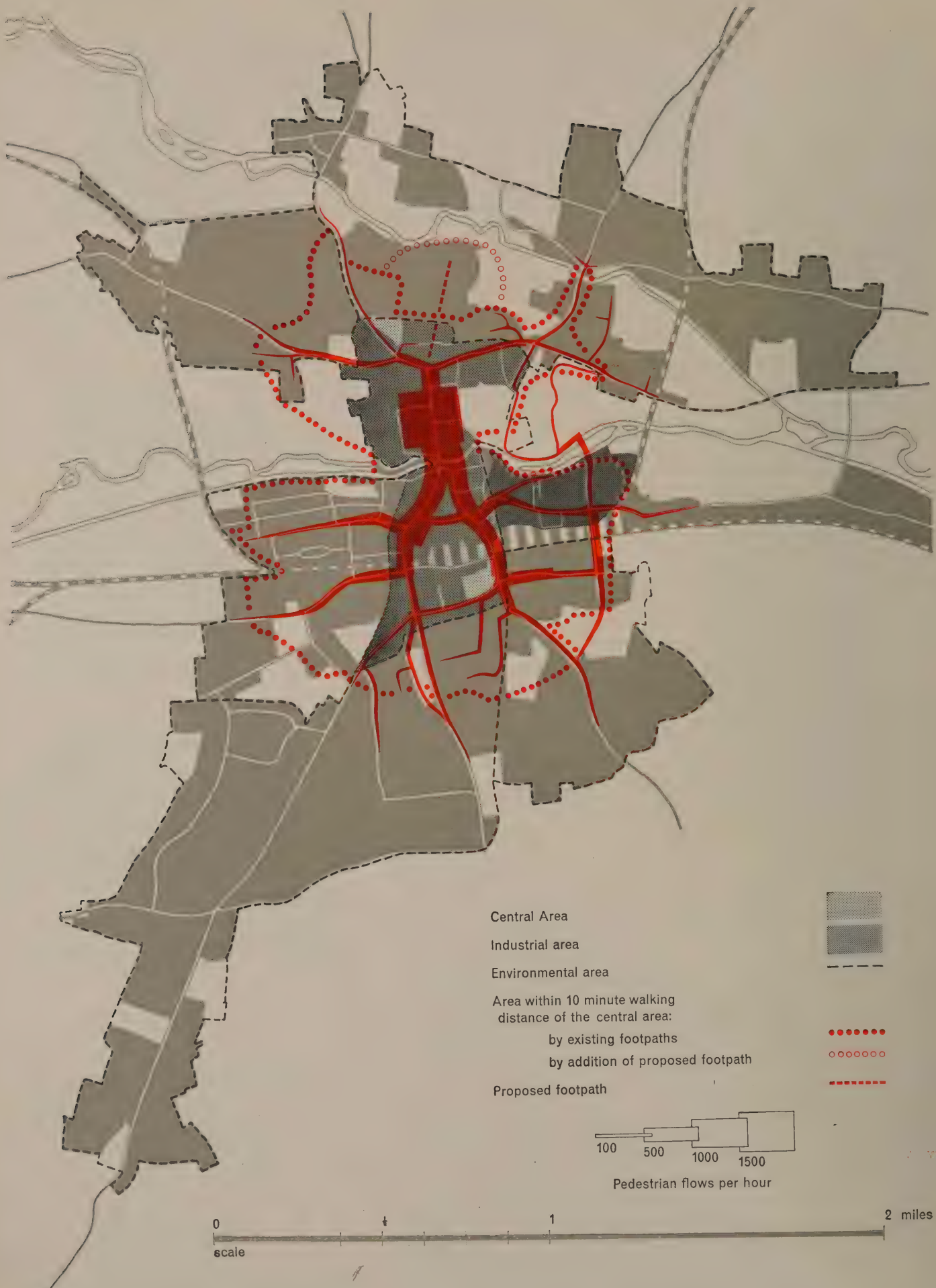


83 The basic form further developed, with separation of the primary and district distributors.



84 The network finally developed.

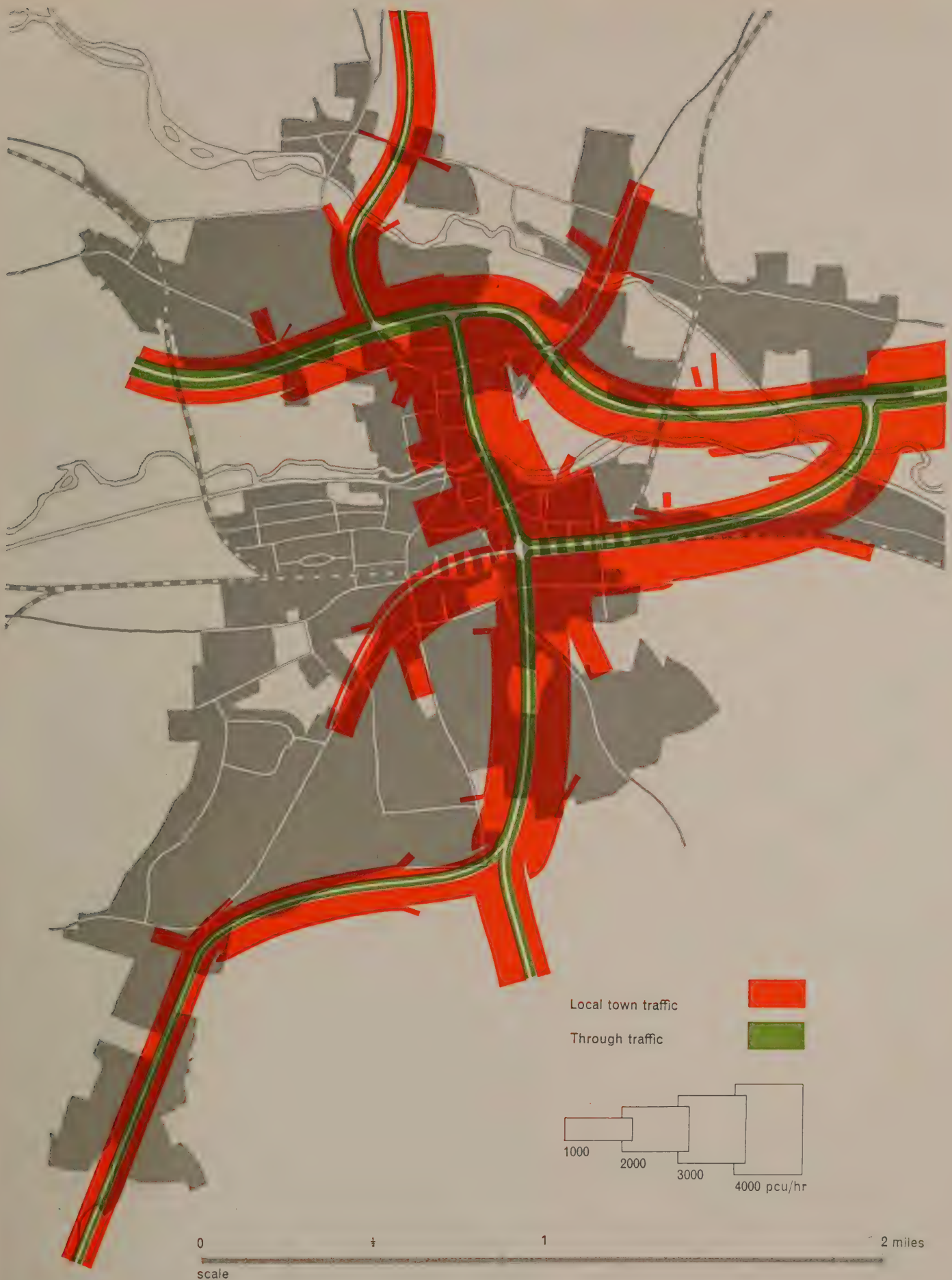
85 The triangle in the centre shows the basis for the new primary network, on the assumption that through traffic on A.34 is removed by a new route to the west, and on A.4 by the South Wales Motorway.



86 Pedestrian movements in relation to the central area of Newbury. A new link is proposed in order to facilitate movement between the centre and the residential area immediately to the north.

87 The provisional breakdown into environmental areas, based on a study of the catchment areas of local shopping centres and primary schools.

88 The proposed new primary network with local distributors and adjusted environmental areas.



89 Future (2010) peak hour flows on the new network.

The town centre

161. We then turned our attention to the crucial problem of the town centre, crucial because the greatest concentration of activities and hence of traffic takes place in the centre. We first analysed the land uses (Figure 91). Northbrook Street is the principal shopping area, but there are other shops outside this street mingled with dwellings, offices and commercial premises. An 'environmental appreciation' revealed many buildings of architectural or historic interest, with particularly pleasant groups near the parish church and the Market Place and in the broad sweep of Northbrook Street. The river, with its old bridge and adjoining open land, and the town park, add greatly to the character of the town centre (Figure 95).

162. The present congestion does much to diminish these intrinsic amenities. There is the disagreeable conflict between pedestrians and vehicles, and most streets are used as car parks, with vehicles parked in all odd corners. The market square functions simultaneously as an open street market and a trunk road. Congestion, confusion and traffic noise are rife, particularly in Northbrook Street and around the parish church and the river bridge.

Objectives

163. The general problem in the town centre is the now familiar one of reconciling accessibility and environment. With regard to accessibility, in view of the future great increase of car ownership, the problem is mainly concerned with the provision of sufficient and convenient parking space, and the vehicular access to it. As to environment, we took it to be a reasonable first assumption that the centre of Newbury should be retained broadly as it stands without sacrifice of the buildings of architectural and historic interest and the present character and atmosphere. Two other objectives for the centre were defined: that so far as possible the centre

90 Newbury—the central area, looking north along Northbrook Street, with the market place in the right foreground.

91 Land uses in the central area.

92 An existing pedestrian shopping alley linking Bartholomew Street and Cheap Street.

93 The Market Place, used as a car park for much of the time.

94 The River Kennet from the bridge. It is a remarkable asset to have such a scene in the centre of the town.

should be made safe, and that living and working conditions should be made secure against erosion by the motor vehicle. These conditions led us at once to the conclusion that for the main streets the choice was limited either to having *no traffic* in them at all, or *a very limited amount under strict control*. We adopted the former, and defined the objective as being to have wholly pedestrian streets, but to admit *service traffic* under strict control where other arrangements were either prohibitively expensive or likely to be long delayed.

Minimum redevelopment

164. On the basis of this environmental objective, a number of possibilities presented themselves for the arrangement of the parking space and access to individual premises. The arrangement in Figure 96 involves no great change or alteration to shopping and business functions. Northbrook Street is wholly for pedestrian use, with rear service access to all buildings. But south of the river, service traffic would have to be admitted into the present main streets. Access for buses could be contrived on routes reasonably close to the centre. Car parks (open surface type) could be arranged conveniently for the Northbrook Street area, but less conveniently for the area south of the bridge. The effect of the open parking would not be pleasant. This scheme might be described as giving good environment with fair accessibility, and with minimum demolition.

165. The number of parking places is a major factor. At present there are about 960 spaces in public car parks in addition to street parking. We estimated that the present maximum number of vehicles parked on a weekday is about 1,600 including those parked within the curtilages of private premises. The present level of car registration is between 200 vehicles per 1,000 persons (Berkshire County average) and 150 vehicles per 1,000 persons (Reading County Borough average). If this ownership level increases as expected to about 400 vehicles per 1,000 persons, and if the degree of usage also increases, then the number of parking spaces required is likely to be between 4,000 and 5,000. We estimated that nearly 2,000 spaces would be needed for long-term parkers (i.e. mostly people employed in the town centre) and the remainder for shoppers and other short term parkers. *This means that car parking, if of the open surface type, becomes the major land use in the town centre.*

Partial redevelopment

166. The arrangement in Figure 97 seeks to get over the difficulty of service vehicles and pedestrians sharing the same routes south of the river bridge. It did not seem possible to accomplish this without fairly extensive redevelopment, as is shown in the plan. The environmental conditions are thereby improved, and the concentration of much of the car parking into a multi-storey garage improves accessibility for the business area.

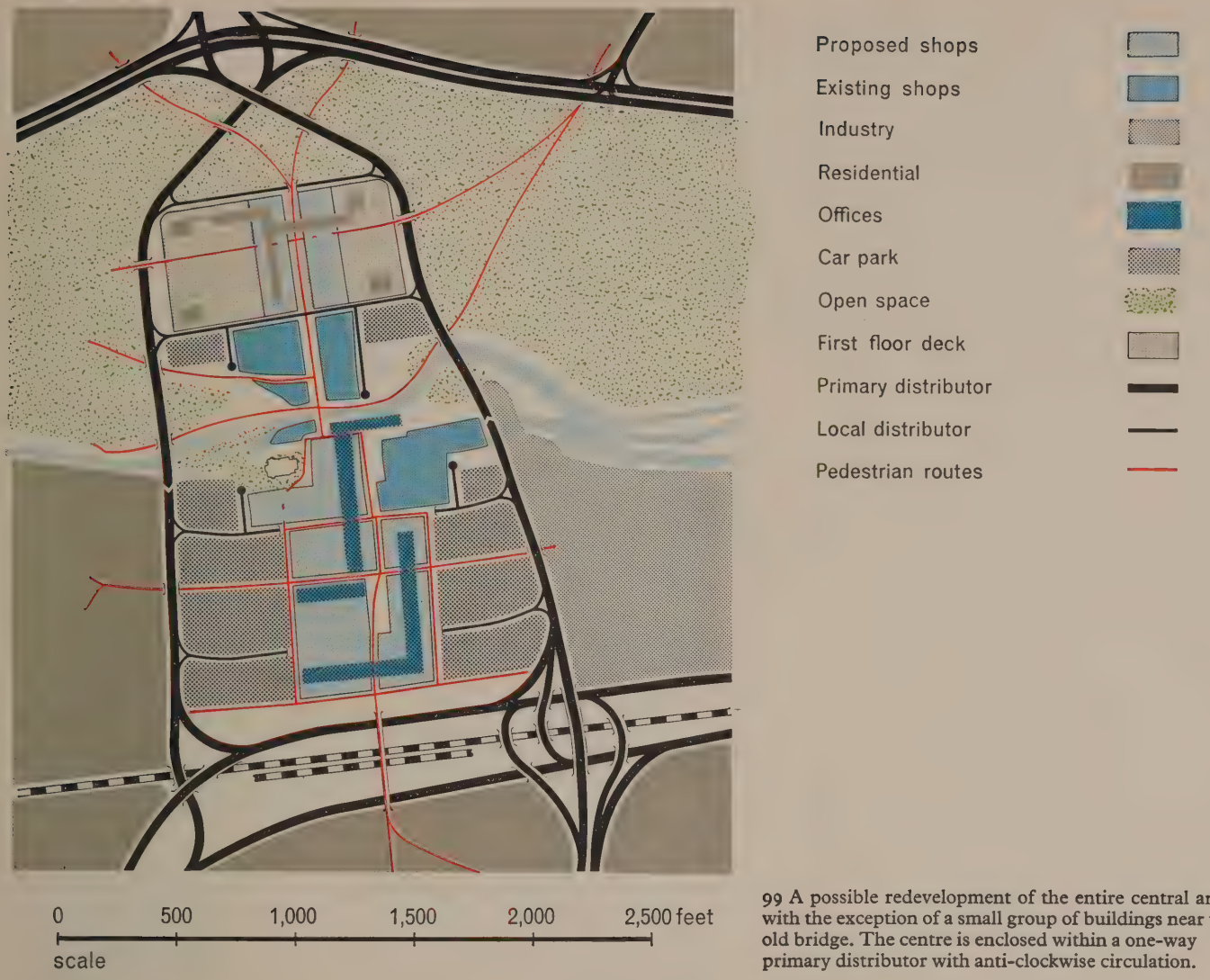
Comprehensive redevelopment

167. In both the schemes so far described, Northbrook Street would be left untouched as far as its buildings are concerned. It would be quite possible (disregarding the question of architectural or historical interest) for the individual buildings to be rebuilt, one by one, without prejudice to the scheme as a whole. We did, however, also consider the advantages of almost complete, staged reconstruction of the whole centre of Newbury, where only the best of the existing buildings would be retained if they would not seriously interfere with redevelopment. A possible scheme is shown in Figure 99 where only the southern part of Northbrook Street, the parish church, and the Corn Exchange area remain. The northern part of Northbrook Street is redeveloped with the whole of the ground level given over to parking and servicing, with shopping and residential accommodation over. South of the river the area is redeveloped with parking and servicing at semi-basement level, ground level shopping, and offices over. This merely illustrates one of many possibilities. The important lesson is that if comprehensive redevelopment can be organised and

95 Environmental appreciation of the central area.

96 The central area with minimum redevelopment. Northbrook Street is wholly for pedestrians, with a new rear access road for servicing. South of the river, pedestrians and service traffic share the existing streets.

97 The design for partial redevelopment. The business area south of the river is redeveloped, with a new bridge over the river to improve the continuity of routes for service traffic.



99 A possible redevelopment of the entire central area, with the exception of a small group of buildings near the old bridge. The centre is enclosed within a one-way primary distributor with anti-clockwise circulation.

financed on a sufficient scale, then the highest standards of environment can be combined with a very high level of accessibility.

A restricted network

168. Finally, we considered what would be the result if the local authority, while accepting that nothing could prevent the eventual build-up of private cars to the maximum, nevertheless decided that it could not face the cost of anything more than a modest network with conventional roundabouts for intersections. We assumed that the environmental standard for the shopping and business streets could not be seriously departed from, and that it would still be necessary to clear all or most of the traffic out. A possible layout is shown in Figure 100.

169. A restricted network of this kind would not be capable of discharging the traffic volumes indicated in Figure 89, because the supply of road space would not meet the demand. On the assumption that means were found to restrict the use of vehicles to match the capacity of the layout, then about 2,000 parking spaces would be required in the centre instead of the 4,000 spaces shown in the previous schemes, and there would have to be a correspondingly greater reliance on public transport.

170. Under these conditions, the general use of cars could increase by about 80% above the present day level, but this would still represent only about 60% of the full potential demand. In such a small town, with a large dependent rural population, it is doubtful whether any acceptable measures can be devised for restraining the use of cars. Congestion on the roads during the rush hours would therefore be inevitable. A limited amount of congestion can be accepted, but there comes a point when the intervals between vehicles are diminished and speeds are lowered, and the

98 (*opposite*) An impression of the market square in the scheme for partial redevelopment looking north. The existing buildings on the east, together with new buildings on the other two sides, are integrated to form a traffic-free concourse.

100 The restricted network.

capacity of the road is actually reduced just when the maximum is most needed. The delays involved may be small to each individual concerned, but when added up over the years for the whole travelling public, and expressed in terms of private and social costs, they are likely to be far more than the cost of the works required to obviate the congestion.

171. Another point which arises from the restricted scheme described in the preceding paragraph, is that an authority which takes cheapness as the criterion of its planning must also accept that the local community will not be able to make full use of motor vehicles, and that there will be a consequent risk of losing business to some nearby locality where better standards obtain. The particular form the risk might take is in the establishment of 'out-of-town' shopping centres catering specifically for car-shoppers. Such centres might be established in the vicinity of several

'restricted' town centres, and would prosper at their expense. With the increasing mobility offered by the motor car, it has to be faced that competition can build up between quite widely scattered centres. The planned development of *suburban* shopping centres may well have an important part to play in diverting some of the movement that now takes place into heavily congested centres. But we think the establishment of purely 'out-of-town' centres in the American style is a potential development that requires careful watching, both for the harm it could do to existing centres (for the maintenance of which many good reasons have been outlined in Chapter I), and for the acute risk that such centres would be the prelude to further urban sprawl.

Costs and benefits of the alternative schemes

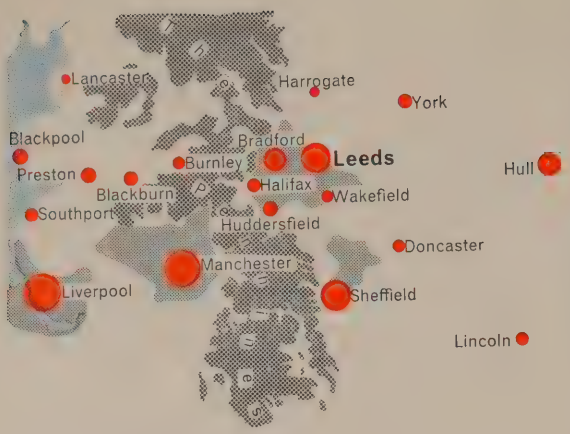
172. The relationship between the cost, accessibility and environment of the various central area schemes is examined in some detail in Appendix 2. It sets out the probable costs and assesses the level of accessibility and environment of each scheme. The appendix explains how cost-benefit analysis can be used to assist in the making of a rational choice between alternatives, particularly public investment alternatives.

Conclusions

173. Although we had to work with the minimum of information, and although we might have explored an endless sequence of variations, we think the general lesson is plain enough that it is possible in a town of about 37,000 people, serving a hinterland population of about the same number, to provide for virtually all the use of vehicles that people are likely to want, but it will require drastic and expensive measures on a scale hitherto unexpected for a town of this size. The capital cost of the fully developed new network (the primary distributors only) would be of the order of £4½ million. If it is objected that the cost is altogether too fantastic to contemplate—and when multiplied out for other similar towns the total is a vast figure—then it can only be replied that the increase in the number of vehicles is by no means fantastic, it is reasonably certain to come about in a town of the type of Newbury with its dependent rural population, so the choice will be either to match the investment in vehicles with an equivalent investment in works, or to invest less in works and *curtail the usage of vehicles*. It is questionable whether anything will curtail the *acquisition* of the vehicles by the public. The great danger for the future would seem to lie in the temptation to seek a middle course by trying to cope with a steadily increasing volume of traffic by means of minor alterations, resulting in the end in the worst of both worlds—poor traffic access and a grievously eroded environment. This case illustrates the 'law' which we propounded in Chapter II, that, given a determination to observe a certain worthwhile standard of environment, the amount of traffic that can be admitted depends upon the money that can be invested in physical alterations.

174. Another important conclusion is that as the use of private cars builds up, public transport by bus is likely to become increasingly uneconomical. Yet without bus services, or some equivalent, many people (the elderly, the young and the disabled, for example) would be immobilised.

175. Finally there is the question whether it would be better to build the outer by-passes first, accepting the temporary relief they would bring, and postponing the more radical alterations to the town itself until the pressure of traffic built up again, or to proceed at once with the new primary network. We think that the most economical course, and probably the best course for Newbury as a town, would be to build the new *primary network* first, and to allow the through traffic to use it for a period of years until the by-passes became necessary. It would be the best course for Newbury because it would immediately give the town a sound framework on which to start building its future, and the environment would be secure.



101 General location of Leeds.

Part Two: A large town

176. Following on from our study of Newbury we turned our attention to a much larger town, selecting Leeds with a population of about half a million. We chose this city because, in spite of the complications presented by near neighbours, it is a major industrial city which is reasonably compact and identifiable. We also knew that useful traffic and land-use statistics were available, though, as at Newbury, this did not obviate the need to make a great many assumptions. We are grateful to the City Engineer for having so readily placed information at our disposal.

Objectives

177. We defined the objects of this study as being:

(i) to assess the number and character of the vehicular movements that would arise as vehicle ownership and use approach the potential maximum, taking into account likely changes in population distribution and land use,

(ii) to indicate the scale and pattern of alternative distributory road networks required to meet varying proportions of the potential demand for vehicular movement, and

(iii) to indicate the impact of increased traffic on the town centre, and the scale of the changes that would be required.

102 The City centre is regional in scale and character.

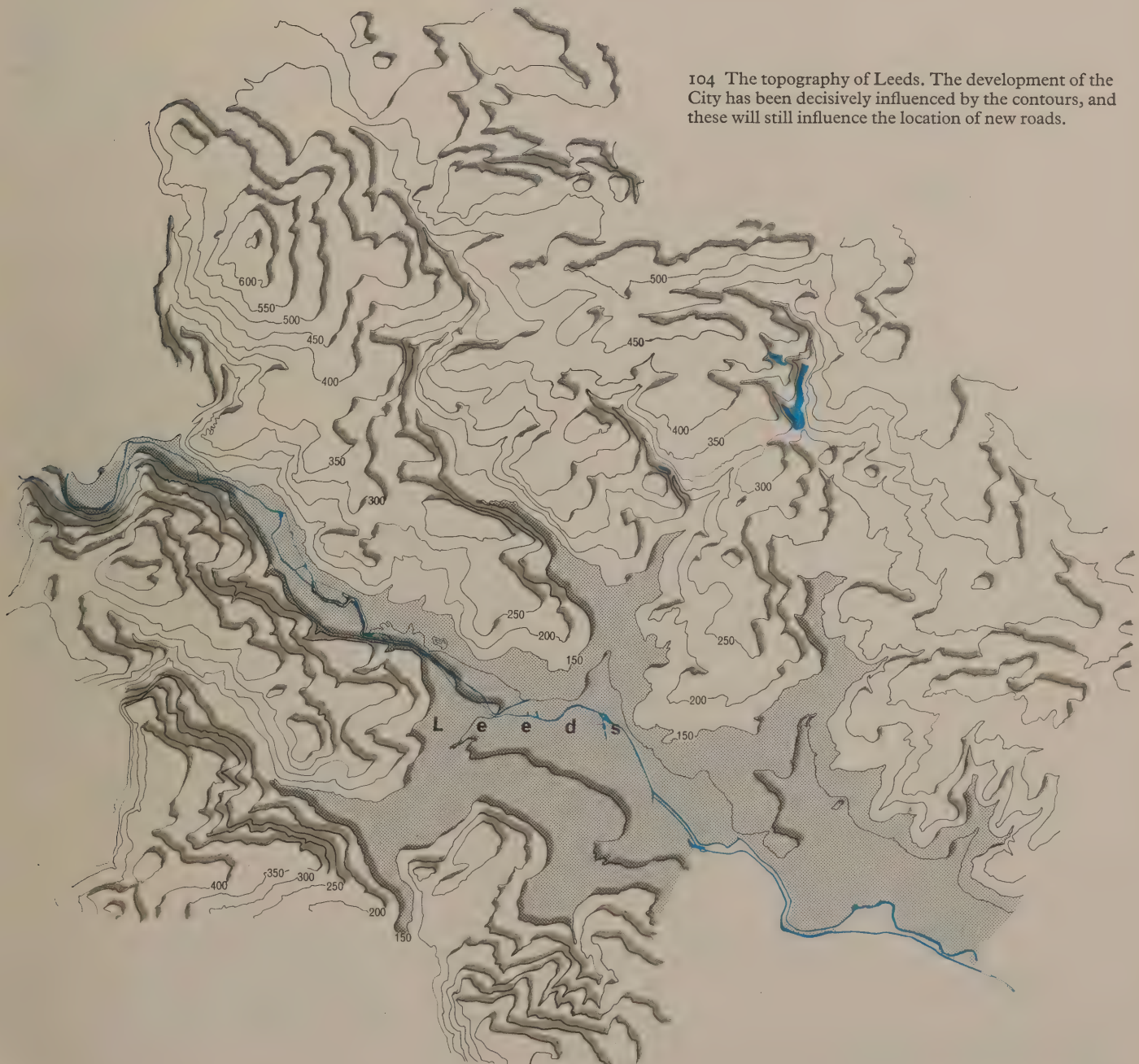
The city at present

178. Figures 101 and 103 show the regional setting of Leeds. The city lies midway between the east and west coasts, close to the eastern slopes of the Pennines, and is the focal point of a network of road and railway communications, including several east-west routes across the Pennines. This concentration of communications will be further emphasised by the termination at Leeds of the M.1 motorway from London, and by the location of the proposed Lancashire–Yorkshire motorway along the southern outskirts of the city. The Figures also show the main concentrations of population. Leeds is the largest of a cluster of towns and villages that make up the West Riding of Yorkshire. This concentration of urban development lies mainly to the west and south of Leeds in contrast to the more rural areas to the north and east stretching into the Vale of York.

179. The population of Leeds itself is about 511,000. Whether this figure will increase or decline will in large part be determined by the density at which new dwellings are built within the city (especially in replacement of existing old houses), the resulting amount of city overspill, and the extent of boundary alterations. It is not, however, expected that the present

103 Leeds is a centre for communications. There is a concentration of urban development to the west and south in contrast to the more rural areas to the north and east stretching into the Vale of York.

104 The topography of Leeds. The development of the City has been decisively influenced by the contours, and these will still influence the location of new roads.



105 The River Aire flows through the city in a pronounced valley, and much of the industry is concentrated along it.

population will greatly change, and for the purpose of this study a future population of about 524,000 for a somewhat enlarged city has been assumed.

180. Although Leeds is more than 60 miles from the sea, some south-eastern parts of the city are only 70 ft. above sea level. The highest parts, however, are over 650 ft. This wide range of levels, and the steeply sloping land, have had a marked influence upon the location of the main road and railway routes. Figure 104 shows the contours, and emphasises the slopes where it would be difficult to locate new roads.

181. Figure 106 shows the main land uses throughout the city. The central shopping, office and warehouse area is clearly defined, and the location of the centre is further emphasised by a major teaching hospital and the university. The city centre is regional in character and scale, serving a

106 Leeds. The main land uses.

wide area east of the Pennines. The River Aire flows through the city in a pronounced valley, with minor tributaries running north and south. Most of the industrial premises are concentrated along the valleys, and are not far removed from the central shopping, business and commercial area. Coal and other minerals have been worked within the city, mainly to the south-east, leaving large areas of waste land to be reclaimed for other uses. As may be seen from Table 1 there is a considerable variety of industries in the City.

182. The age of residential buildings in Leeds is shown in Figure 107. It can be seen that around the central business and industrial areas there is much old, nineteenth century housing, presenting a great opportunity for comprehensive redevelopment. Most of the modern residential areas have spread extensively over the northern half of the city, and, to a lesser extent, onto areas of higher ground south of the River Aire.

183. The main feature of the land use pattern of Leeds, and unquestionably the most important from the point of view of our study, is the close proximity of the principal industrial areas to the central business area. This results in a great daily concentration and convergence of movement as people come into work from the widely-spread residential areas of the city.

Table 1: Persons employed in each of the main employment groups, expressed as a percentage of the total number of persons employed

	%
Clothing and Textiles	20
Engineering	17
Other manufacturing industries	13
Transport and communications	5
Distributive trades	14
Professional, scientific, services, public administration, banking, etc.	15
Miscellaneous services	16
Total	100

107 The age of residential buildings in Leeds. Note the extensive areas where the buildings are now over 70 years old. This indicates not only the great burden of reconstruction that lies ahead, but also the great scope there is for imaginative work. Most of our industrial cities are in the same state.

The main future movements

184. We then turned to the first of the objectives set out in paragraph 177. We confined our attention to three types of movement, and their numbers as vehicle ownership approaches the maximum:

(i) journeys to and from work,
(ii) shopping journeys, and
(iii) industrial, commercial and business journeys.

These would not account for the whole of the urban movement by any means. Social and recreational movements, journeys to school, and many other casual and less regular journeys also take place. All these additional movements would together amount to about 20% of the whole, but either they tend not to occur during the peak periods of the three main classes of movement, or they are not great in volume, and therefore will not radically affect the pattern or size of the primary network.

185. To ascertain the direction and volume of the three main kinds of movement we employed the same 'gravity model' technique that we used for Newbury. We divided the whole city into zones, and then estimated the inter-zonal movements that would be likely to take place having regard to the resident and/or employed population in each zone, the amount of floor space devoted to particular land uses in each zone, the distances between zones, and the travel habits of people in given circumstances. We do not suggest that this method based on estimates is a substitute for an actual travel survey, but since such a survey would have taken many months to organise and to process, it was the only method open to us.

Journeys to work

186. We estimated that the future number of people living *and* working in Leeds would be 228,500, with about 20,000 travelling *out* of the city to work every day and about 46,000 travelling *in* to work. We then sub-divided the area of the city into ten residential and ten employment zones, and estimated the number of workers living or employed in these zones with a further breakdown between those employed in manufacturing industries and those otherwise employed (Figures 108 and 110). We knew from existing statistics that, for the whole city, 56% of the employed persons worked in manufacturing industry, and we built up the figure for each employment zone from figures available for the postal areas. We assumed that 75% of the non-manufacturing employment was in or near the city

108 The ten residential zones used for the analysis of the work journeys.

Zone	Resident population	Employed population (within Leeds)	Total in manufacturing industry	Total in non-manufacturing industry
A	36,650	16,000	4,800	11,200
B	63,840	27,800	8,300	19,500
C	129,860	56,500	34,900	21,600
D	34,390	15,000	9,200	5,800
E	33,590	14,600	9,000	5,600
F	59,670	26,000	16,000	10,000
G	56,310	24,600	15,200	9,400
H	24,060	10,500	6,500	4,000
I	52,080	22,800	14,000	8,800
J	33,770	14,700	9,100	5,600

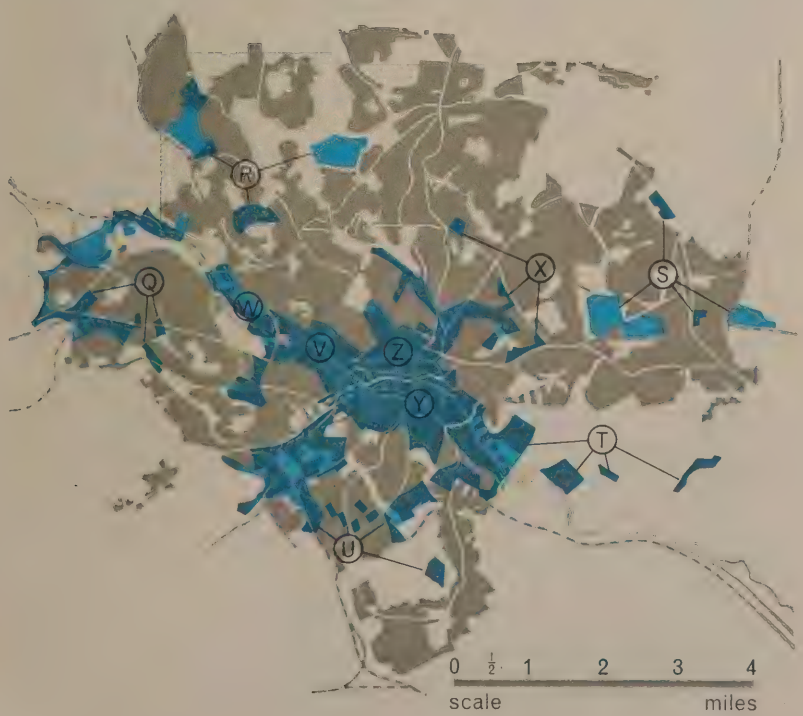
109 Estimated car ownership levels in Leeds in 2010.

640 cars/1000 persons
380 cars/1000 persons
285 cars/1000 persons

centre and 8% (or 30% of the remainder) within the residential areas. The remaining workers were 'allocated' proportionately to each employment area, with a 'weighting' to take account of some preference for proximity between home to workplace.

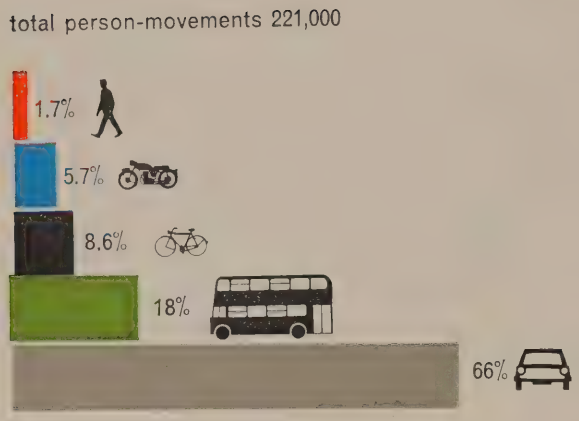
187. Thus we established the major movements of people between residential areas and employment centres. We could have obtained a *finer* picture had we been able to divide the city into a greater number of zones, but the number of cross-calculations that are involved increase rapidly as the number of zones is increased, and it would have been beyond our resources to deal with a much larger number.

188. We then had to consider by what means of transport these movements would be made. Car ownership in Leeds is at present slightly below the national average, but we assumed it would reach the future national figure of 400 cars per 1,000 population in the year 2010. This gave a total of nearly 210,000 cars for the city. But we realised that ownership would not be evenly spread (Figure 109), and so we assumed a variation from an average of about 2 cars, in some of the northern outskirts of the city, to about 0·9 cars per household in the innermost residential areas. For our first exercise we assumed that the use of cars would be uninhibited by traffic congestion or restrictions, but a good deal influenced by such factors as



110 The ten employment zones used for the analysis of the work journeys.

Zone	Total employed (resident in Leeds)	Total in manufacturing industry	Total in non-manufacturing industry
Q	9,100	7,600	1,500
R	3,100	100	3,000
S	10,300	7,300	3,000
T	14,700	13,200	1,500
U	15,600	14,100	1,500
V	10,600	9,100	1,500
W	11,800	10,300	1,500
X	22,800	19,800	3,000
Y	31,900	30,400	1,500
Z	91,300	15,300	76,000



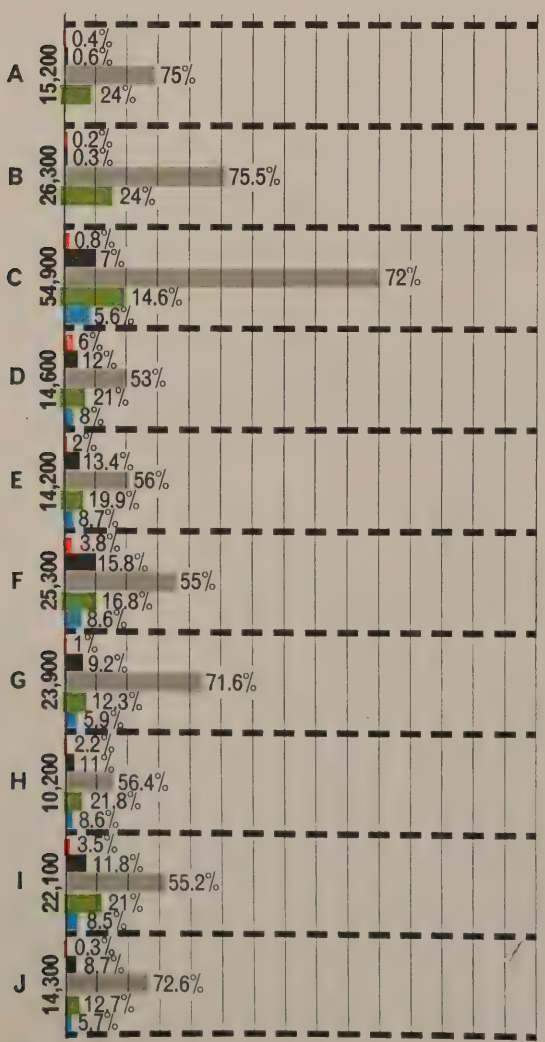
111. The mode of travel ex-residential areas (*left*) and ex-employment areas (*right*) for the work journeys in 2010. The key shows the proportions for the various modes of travel for the total work journeys in the city. The total number of movements is less than the total employed population shown in Figure 108 as it does not include persons who both live and work in the same zone.

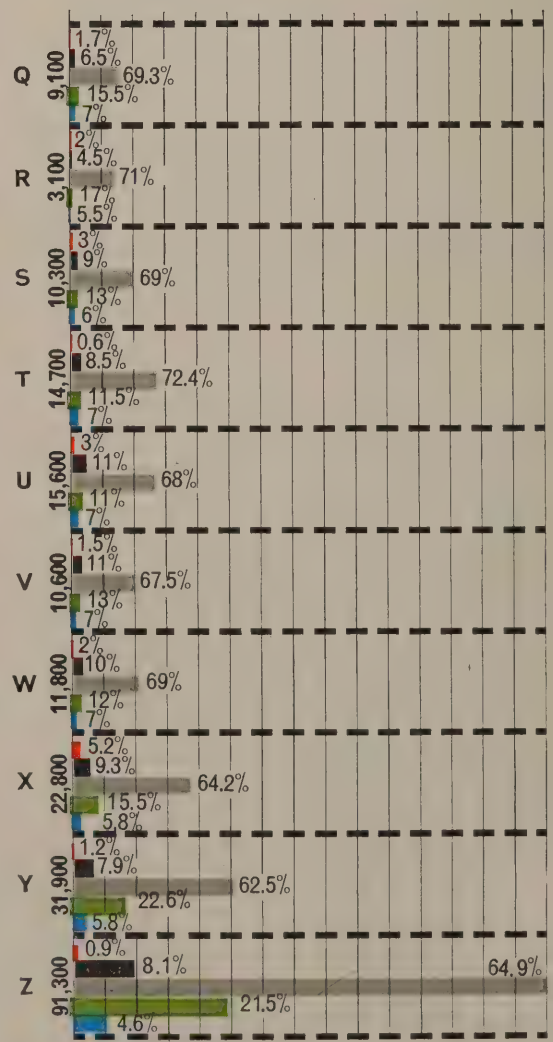
the number of workers in the family, the availability and convenience of public transport, and the likelihood of people walking to work if the journey were half a mile or under. From all this we concluded that the proportion of people who would desire to go to work by private transport would vary between 56% and 83% depending on the kind and location of the residential area involved. Figure 111 shows the 'mode of travel' for the work journeys from each of the ten residential areas or zones and to each of the ten industrial zones, for these conditions of full car ownership and unrestrained use.

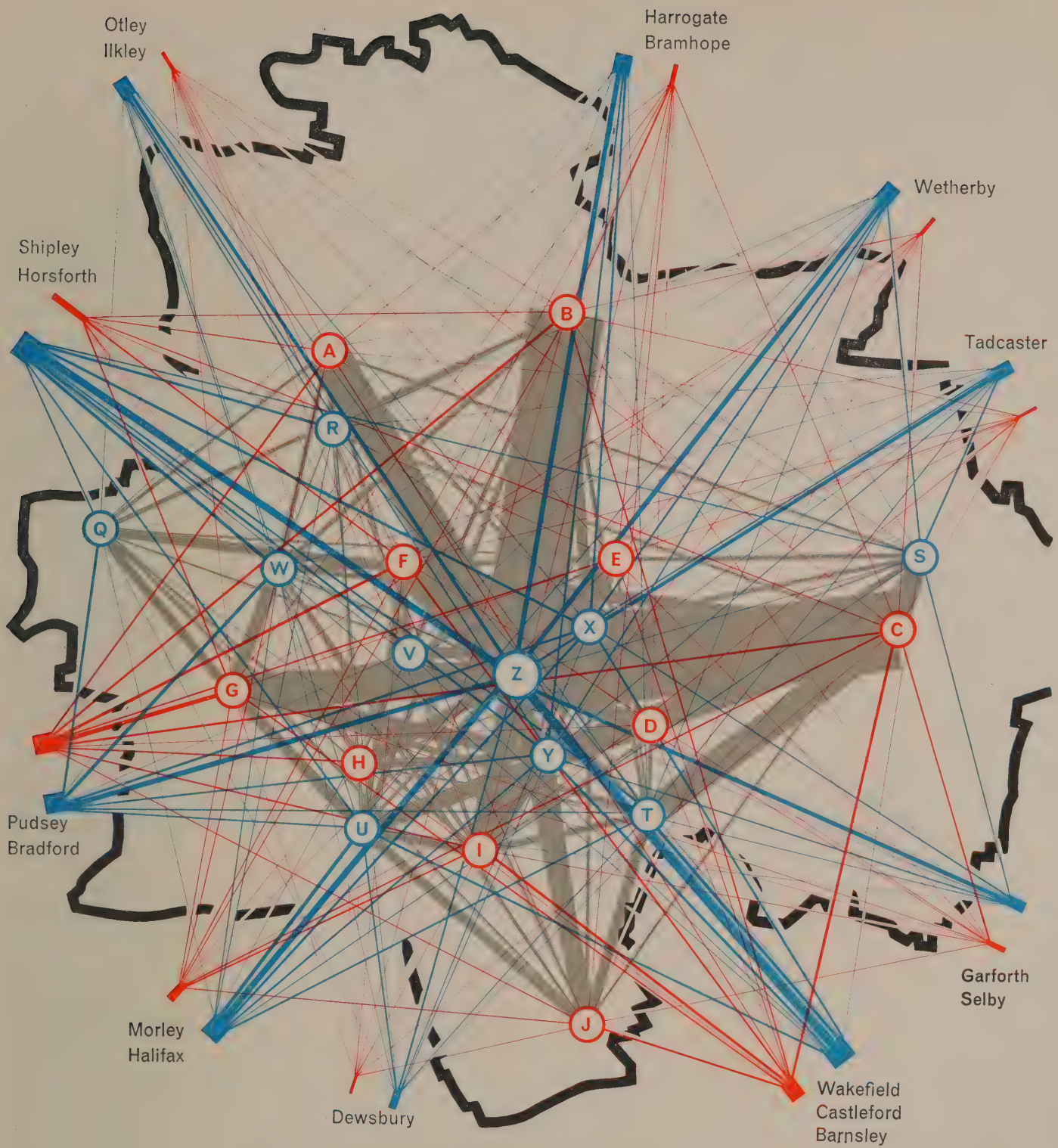
189. We were now able to draw the critical desire line diagram for the work journeys. This is shown in Figure 112. It indicates the number of vehicular journeys in 2010 which will be desired between the employment and residential zones during the peak hour. For the purpose of this diagram it has been assumed that the movements allocated to 'public transport' in Figure 111 would take place by *bus* since there is little short-distance transport by rail in Leeds. Most of these journeys will be concentrated into a short space of time, and will form a major component of the peak period flows. In order to determine the volume of traffic that will arise during the peak hour, we assumed that at least the present amount of 'staggering' of working hours can be maintained so that, considering the city as a whole, no more than 70% of the total work journey movement takes place during this critical period. Figure 112 clearly illustrates the effect of the great concentration of employment in and around the central part of the city.

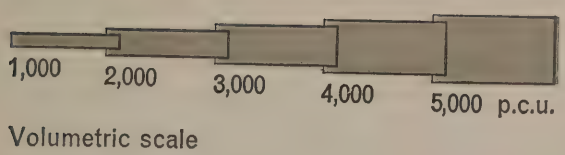
Shopping journeys

190. For the suburban areas of Leeds, we assumed an average of three shopping journeys per family per week to local centres, together with one weekly journey to the town centre. We assumed that other shopping









Volumetric scale

External traffic in
out

Internal traffic

112 Desire lines for the work-journeys by vehicle during the peak hour in 2010. The centres of gravity of the residential zones are indicated by the red circles and those of the employment zones by the blue circles. The grey lines represent movements between employment zones and residential zones within the City; the blue lines movements between employment zones in the city and residences outside; the red lines movement between workplaces outside and residential zones inside the city.

journeys to the *town centre* would vary between 2·5 journeys per family per week from the nearby residential areas, to 0·33 journeys per family per week from more distant places outside Leeds for which the city serves as a regional shopping centre. We identified seven main suburban shopping centres. After allowing for a proportion of shoppers who could be assumed to be prepared to walk for distances up to half a mile, and allowing also for the fact that a number of family cars would already be in use for the journey to work and thus not available for shopping, we deduced that the proportion of shoppers using cars in 2010 would vary between 100% and 35% according to the car ownership level in any particular area and the availability of public transport. We assumed that there would be a higher proportion of car use in the more remote parts of the city.

191. Since the busiest shopping day of the week in Leeds (Saturday) does not coincide with the peak hours for work journeys and the industrial and commercial flows, we looked for the busiest normal weekday. We found that this varied between Tuesdays, Thursdays and Fridays according to the class of trade. The available statistics of trading turnover, however, showed that the Saturday turnover was about one third of the weekly total, and that Friday came next with one fifth. The busiest shopping day was therefore taken as one on which about one fifth of the total weekly trips were made.

192. Finally we assumed that 10% of the daily shopping journeys from the town centre would take place in the evening peak period, and 15% of journeys from the suburban shopping centres in the same period.

193. On the basis of these assumptions we estimated the number of daily shopping journeys to the *central area* at 67,000* of which 64% would be by car and the remainder by public transport. The daily journeys to the seven suburban centres we established at nearly 48,000, of which 71% would be by car, 22% by public transport and 7% on foot.

194. We were then able to draw a desire line diagram for shopping traffic, as shown in Figure 113. It distinguishes between: (i) journeys to the town centre from nearby residential areas, (ii) journeys to the town centre from the other residential areas of the city, (iii) journeys to the town centre from outside Leeds, (iv) journeys to the main suburban shopping centres from adjoining residential areas.

Industrial, commercial and business journeys

195. These journeys were by far the most difficult to analyse because of their great variety, and the dearth of information about the generation of this class of traffic. Fortunately, surveys had recently been made by the local authority of traffic crossing the city boundary on the main radials, of distribution depots within the city, and of all firms employing more than 50 persons. These provided us with some working material, and enabled us to distinguish between traffic associated with manufacturing and non-manufacturing industry, and gave a cross-section of the number of persons working in each type of industry in each postal district of the city, together with the total floor space occupied by each firm. From this we were able to evolve an average ratio of floor space per employee for each of 25 different types of industry (15 manufacturing and 10 non-manufacturing). We also obtained some additional information from a number of concerns by direct interview. These included British Road Services for their parcels and bulk transport, British Railways for their parcels, bulk transport and fish, meat, fruit and vegetable traffic, and Tetley's Brewery (Figure 114).

196. From all this information we worked out *present day* 'traffic generation factors' for each of the 25 industrial groups. These factors were expressed in terms both of journeys per day per unit of floor space, or journeys per day per number of employees,† and they distinguished between journeys

* This figure does *not* include trips originating from within the zone of destination, e.g. people working in the central area who shop at lunch time.

† For example, for manufacturing industries, generation factors ranged from 1 trip per 1,500 sq. ft. to 1 trip per 6,000 sq. ft. of floor area, and for non-manufacturing industries the range was from 1 trip per 200 sq. ft. to 1 trip per 2,500 sq. ft.

Journeys to the town centre
- from nearby residential areas
- from other residential areas
- and from outside Leeds

Journeys to main suburban shopping centres from adjoining residential areas

113 Desire lines for the shopping journeys by vehicle during the peak hour in 2010 to the same scale as the work-journey desire lines.

made by car, van or lorry. For the city as a whole we estimated the proportion of journeys made by each of these three types of vehicle, the results being shown in Table 2.

Table 2: Journeys made by cars, vans and lorries as a proportion of all journeys connected with industry

	Manufacturing Industries	Non-Manufacturing Industries	All industries
Cars	50%	32%	36%
Vans	10%	40%	31%
Lorries	40%	28%	33%
	100%	100%	100%

197. We then applied the traffic generation factors to a sample number of industrial firms in each of the employment zones (i.e. the zones which we had previously distinguished in connection with the analysis of journey to work), and by 'scaling up' we arrived at the total number of journeys for each zone.

198. Thus far we had dealt only with traffic connected with manufacturing and non-manufacturing industry. The big remaining gap was the traffic connected with the distributive and service trades which account for 14% of the total labour force of Leeds. Traffic generation factors were again derived, based on the ratio of numbers of employees to floor space occupied. This procedure was carried out for the central area, and for each of the seven suburban shopping centres.

199. Having arrived at an estimate of the number of vehicle movements generated by each employment zone, we then had to make broad assumptions as to the directions and length of the movements so generated. These assumptions, which are set out below were necessarily very tentative because there was little or no knowledge available.

Manufacturing industrial traffic	Percentage of total movements
Movements between industrial zones within the city and places outside the city	80
Movements between industrial zones within the city	20
	100
Non-manufacturing industrial traffic	
Movements between zones within the city and places outside	30
Movements between zones within the city	25
Movements between industrial zones and residential zones	20
Movements taking place within the industrial zone of origin	25
	100
Distribution and service traffic	
Movements between zones	60
Movements within the zone of origin	40
	100

200. In estimating the directions of flow between zones within the city and places *outside*, we applied 'weightings' based on present-day volumes of traffic (as known in detail) on each of the radial roads. Flows between zones within the city were weighted in accordance with the amount of floor space in each zone. It was possible to check the results of our allocations as far as movements across the city boundary were concerned, against the known flows revealed by the local authority's survey. They were found to give quite comparable results.

201. Finally, since all these computations gave us only present day movements, we projected them to the year 2010 by means of a growth factor of 2·66*. Thus we were able to draw the third desire line diagram (Figure

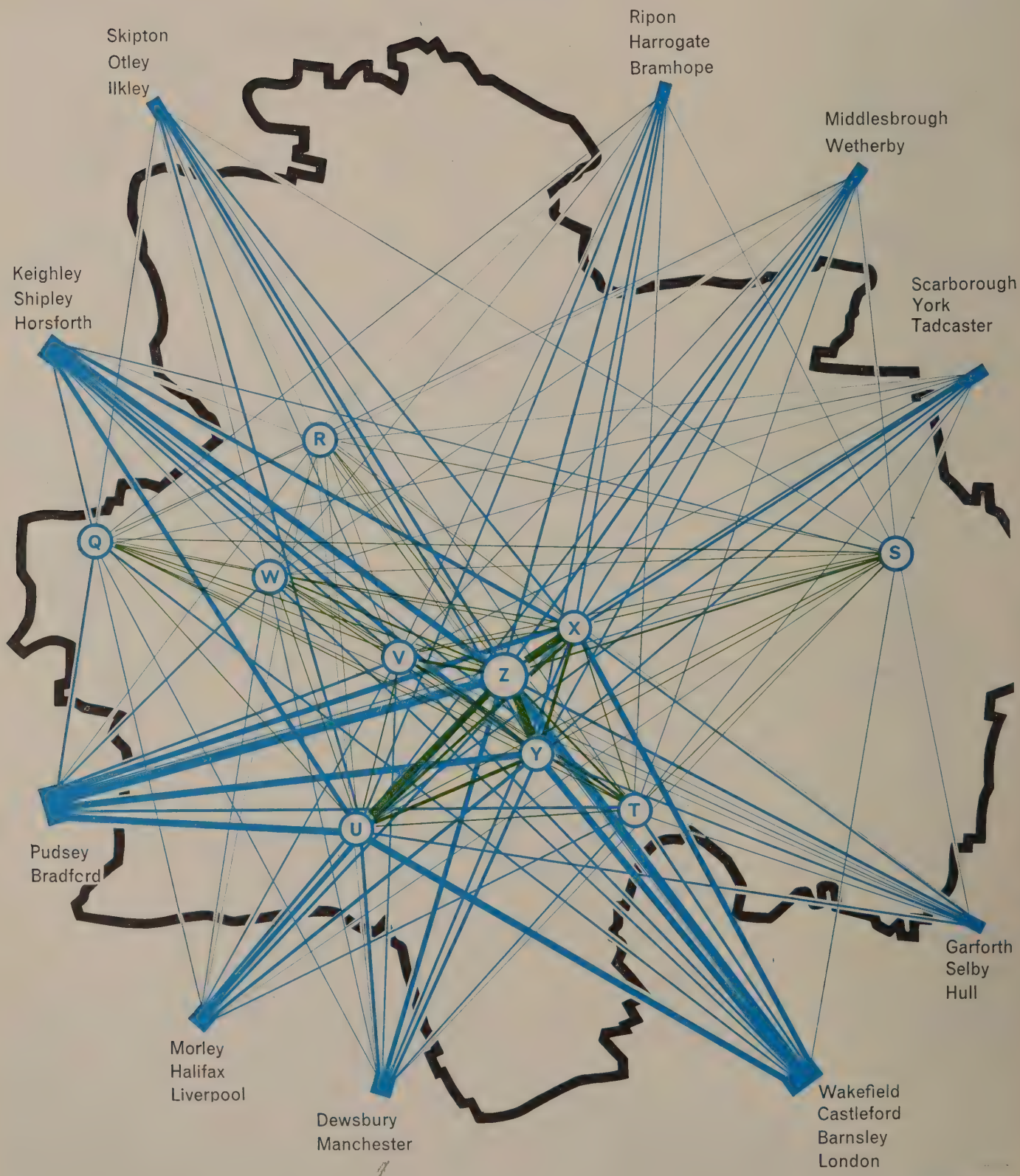
* This projection, involving the use of a single global growth factor, is a very crude one, since it takes no account of the many modifications that will inevitably occur in the local pattern of industry, or in the manufacturing processes or the supply and delivery arrangements. It is, however, the only one possible until further studies are carried out in this field. It is related to the expected general increase in the total number of commercial vehicles in use by the year 2010 ($3\frac{2}{3}$ times the present day), but as this total fleet will be owned by, and operate from, many more business concerns than exist today, the growth factor assumed for the generation of journeys by a given amount of floor space is expected to be less than this increase, notwithstanding an expected slight increase in the use of each individual vehicle.

114 Volume of traffic generated at present by British Road Services, British Railways and Tetleys Brewery in connection with their bulk deliveries. It should be noted that the volumetric scale of this diagram is 75 times that of the other desire line diagrams.

115). This shows the movements in the year 2010 which would take place entirely within the city, and those which have an origin or destination outside the city.

Summary of traffic movements

202. The estimated daily total number of journeys arising under these conditions would be slightly over 1,000,000 with nearly 150,000 taking place during the peak-hour. A percentage breakdown of these totals into four types of traffic is shown in Table 3.



115 Desire lines for all industrial, commercial and business journeys during the peak-hour in 2010, to the same volumetric scale as the work-journey desire lines.

Table 3: Types of traffic as a proportion of daily and peak hour journeys

Type of traffic	Percentage of total daily journeys	Percentage of peak hour journeys
Work journeys	35	71
Shopping journeys	12	5
Commercial and industrial journeys	33	19
Other journeys	20	5
Total	100	100

The primary network

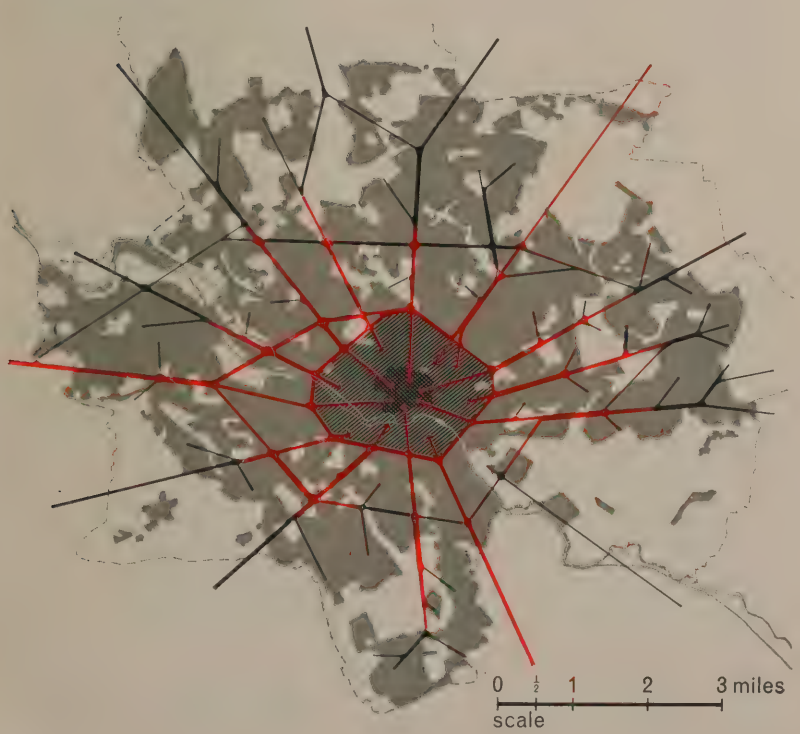
Theoretical network for full car ownership and use

203. From the three desire line diagrams we were able to determine the amount of peak-hour movement crossing a series of 'screen lines'. These gave us specific volumes of traffic to be catered for, and from these we were able to evolve the theoretical road network required to discharge the conditions of full car ownership and unrestrained use. This theoretical network takes no account, of course, of local environments, existing development, or physical features, nor does it take account of any through traffic. (Figure 116)

204. The following are the main features of the theoretical network:

(i) Thirteen radials connect the outer suburbs to the main employment areas in and around the town centre. These radials increase in capacity as the centre is approached in order to deal with the increasing loads, but towards the centre they are split up for the better distribution of traffic. To give the required capacity all thirteen radials would need to be designed to motorway standards through the *inner* suburbs. Six of these would in places need to be eight lanes wide, some of these lanes being reversible (i.e., taking inward traffic in the morning and outward traffic in the evening). Through the *outer* suburbs only three of the roads (those leading to Bradford, Wakefield and Wetherby) would need motorway specification, the rest could be built as roads for all classes of traffic with intersections on one level, but not, of course, providing direct access to premises.

(ii) A series of motorway cross-links, varying from four to six lanes wide, distribute cross-town movements between residential areas and outlying employment areas, and link both these types of area to the main routes out of the city.



116 The theoretical primary network for full car ownership and use. Distributors shown in red would require to be of motorway standard. The thickness of line indicates the relative size of highway required. Figure 117 shows three alternative methods of attaining continuity of the distributors in the central part of the city.

117 Three alternative arrangements for the treatment of distributors within the central part of the city.
The first shows a ring and radial system. The second is based on a grid. The third is a two-tier hexagonal system. All three would be virtually impracticable for reasons of space, design, or proximity of interchanges.

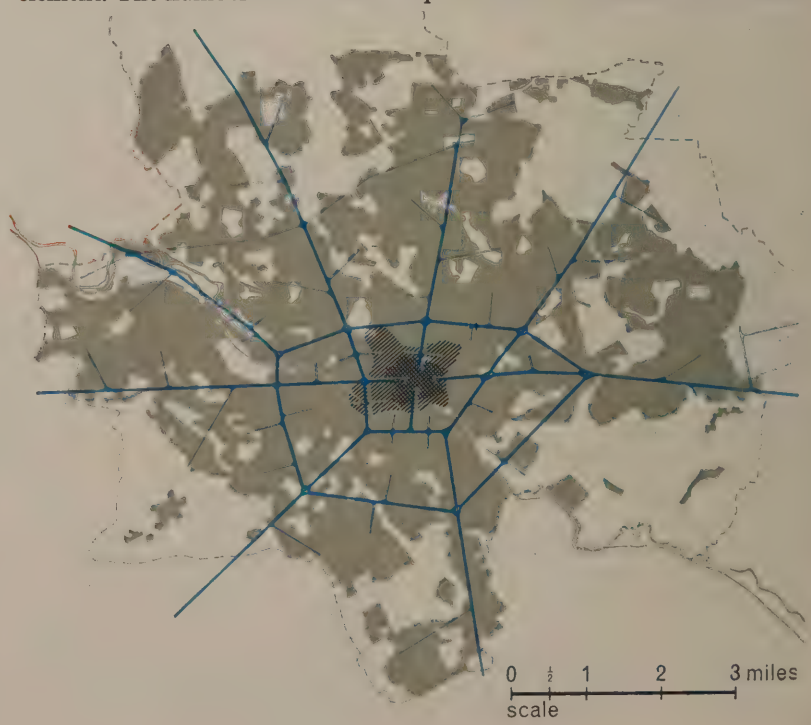
(iii) In the central part of the city, the network which is needed would be quite impracticable. In theory, the area inside the inner limits shown on the diagram could be served by a series of cul-de-sacs. Six would have to penetrate as far as the central business area, and a further eight would be needed to serve the densely developed belt around this. Such a system would however throw an additional load onto the cross-links, which would then be quite unmanageable. Three possible arrangements have therefore been examined which provide direct access to all parts of the centre (Figure 117). The first is based on a conventional ring and radial system; the second is based on a grid-iron plan with a bias towards the area of greatest traffic generation in the centre. Both of these would be quite impossible in practice, because the distance between the intersections of the network is so small that there would be little or no opportunity to provide access to the very area it sets out to serve. The first also produces the greatest concentration of traffic at the very heart of the centre where new road works would be the most difficult and costly to construct. The third scheme is based on a two-tier system of one-way hexagons, the inner system being more tightly-knit and made independent of the outer by means of connections direct to the network. It is considered that this would be just about feasible, but only if it were possible to redevelop the whole of the area covered by the hexagons, some 2,000 acres.

205. It is thus concluded that there is no possibility whatsoever, in a town of this size and nature, of planning for the level of traffic induced by the unrestricted use of the motor car for the journey to work in conditions of full car ownership.

A minimum network

206. The outline of our calculations will have made it clear that work journeys by car accounted for the greater part of the traffic volumes that would arise, and hence for the need for an elaborate network. Coming to the other extreme, we then examined the scale of network required to deal only with the essential industrial business and commercial traffic, together with sufficient public transport (buses) to carry all persons travelling for other purposes.

207. Figure 118 shows the theoretical network required for this minimum traffic. The pattern is substantially different from the first network, because the industrial and commercial traffic now becomes the dominant element. The number of new roads required would be much fewer because



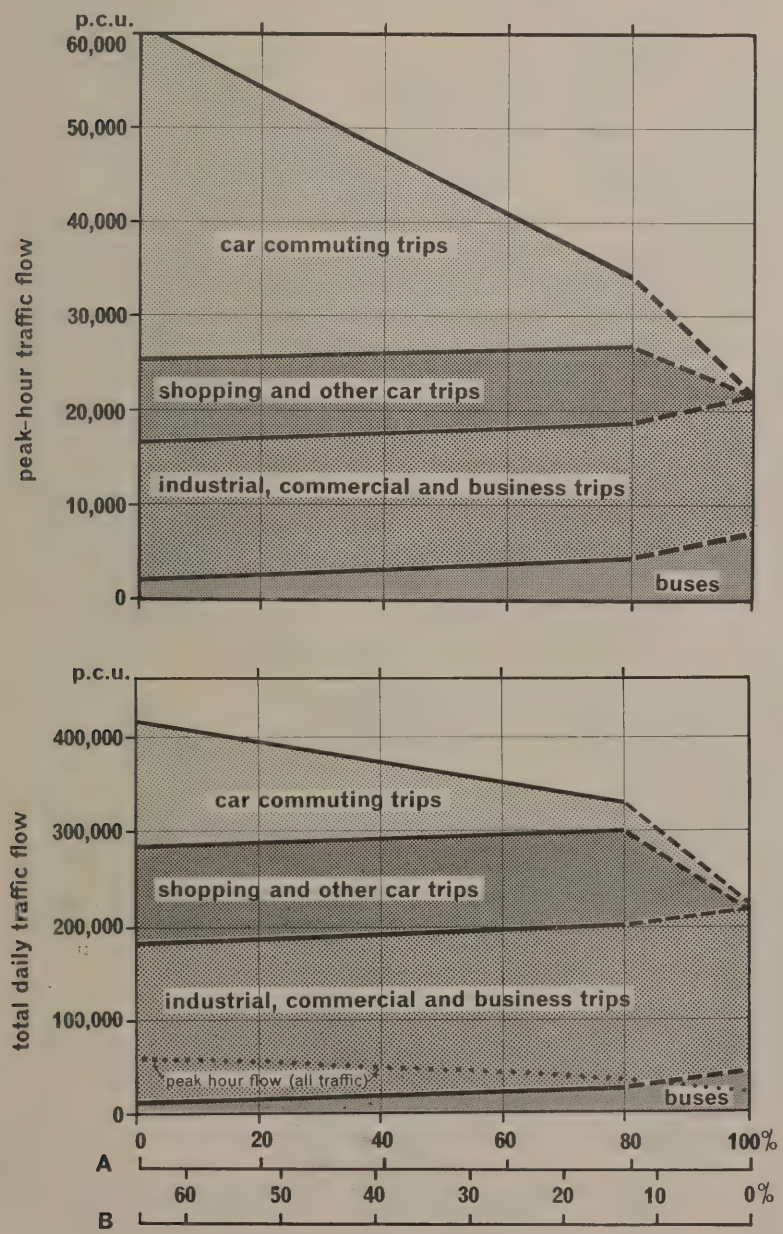
118 The theoretical network for essential traffic only.

the peak period work-journey traffic is, of course, dramatically reduced by eliminating commuters' cars. Even so the existing road network would need to be augmented by the provision of about 18 miles of new road of three or four lane capacity, together with about 35 new or re-made intersections. This length of additional road does not take account of new links which might be required on environmental grounds, for example to remove traffic from a shopping centre located on a main radial road.

An intermediate network

208. The first of the two preceding exercises demonstrates that full car ownership and use in a city the size of Leeds postulates a network of such formidable dimensions that it could not be faced. Yet we are quite sure the public would not accept the other extreme, demonstrated in the second exercise, of confining personal movements to public transport. Between these extremes is a wide range of alternatives. The choice in practice would depend on many factors, from the scope for redevelopment to national and local capital investment policies.

209. But it is abundantly clear that the scale of the primary network is markedly influenced by the extent to which private cars are used for the journey to work. This point is illustrated in Figure 119. This shows how the total flow during the peak hour sharply declines as the use of cars for the work journey is progressively reduced, even assuming (as here) that the commercial business and industrial traffic is unrestricted.



119 Estimated peak hour and daily traffic flows from the central part of the city with varying degrees of restraint on the use of private cars for the work journeys.

A degree of restriction on use of car

B proportion of all persons travelling to work who go by car

210. The converse of the conclusion demonstrated in Figure 119 is that for a given road system having a certain peak flow capacity, if it is assumed that there should be no restriction on the peak period use of essential vehicles and cars for shopping and other non-work purposes, then the proportion of all persons who can go to work by car is predetermined.

211. Figure 119 also illustrates the same relationships in terms of the total *daily flow*. The decline in total flow as the use of cars for journeys to work is progressively reduced, is less sharp. Car commuters' trips form a much smaller part of the total daily flow, even where their use is unrestricted.

212. An authority faced with the problem of deciding what level of traffic to cater for would have many alternatives to choose from. But it is to be presumed, in view of the general demand for unrestricted use of the motor car, that the greatest possible effort would be made to satisfy the demand. This has been the objective affecting our own choice of an intermediate network with which to demonstrate the process of adapting a network to the actual conditions of the city. The case we have considered is one in which the use of cars for the journey to work is fixed at the following levels:

(*a*) Journeys to the central employment zone (z)—40% of potential demand.

(*b*) Journeys to the inner employment zones (v, x, y)—70% of potential demand (excluding the central zone).

(*c*) to the outer employment zone—no reduction.

213. The remaining journeys to work would be by public transport. It is important to note that the percentage figures relate to the potential demand, not to the total number of persons employed. Thus 40% of the potential demand for travelling to work by car to the central zone would represent about 26% of the total persons employed in the centre.

214. The theoretical network for this level of traffic is shown in Figure 121.

120 Suburban shopping centre astride an existing radial road at Harehills. The environment is already seriously affected by traffic.

Environmental areas

215. Before proceeding to fit this theoretical intermediate network into the actual development of the city, we examined the whole city in order to determine the possible arrangement of the city into groups of environmental areas. We could not, of course, at this stage, delineate all the individual areas, but we could define the main groupings, and decide which sections of the city possessed a homogeneity which prima facie should not be cut up by major distributors. We could also identify the areas where environment is already being seriously affected by traffic. Many of these are situated on the existing radial roads where old village settlements have developed into important suburban shopping centres.

121 The theoretical intermediate network which would meet about 40% of the potential demand for travelling to work by car in the central zone. The distributors shown in red would need to be built to motorway standards.

Figure 123 shows a tentative grouping of environmental areas, and conversely, the lengths of road where the clash between traffic and local environment is already pronounced.

Shortcomings of the existing network

216. We also examined the existing main road system to assess its suitability for forming part of the new main network. The study showed (Figure 124) that great variations exist in the carrying capacities of the existing roads. These are most deficient near centres of activity where high capacity is most needed. The diagram also shows: the lengths of road where serious congestion already arises; areas where there are comparatively few private garages, with the result that the streets are extensively used for all-night parking; points where accidents involving pedestrians repeatedly occur; points where there is a major traffic or environmental defect in layout; and points where police control is required at peak hours to augment or replace automatic control.

122 Chapeltown, a suburban shopping centre seriously affected by traffic.

123 Environmental appreciation.

The theoretical intermediate network adapted

217. Figure 125 shows the outcome of the above studies. The theoretical network has been 'bent on' to the topography of the city, taking account of the main environmental area groupings. We would again emphasise that this diagram is in no sense put forward as a 'plan' for Leeds. We think it can be taken as a firm indication of the kind and scale of primary network that would be required for Leeds (or any other city comparable in size and form) in order to deal properly with the level of vehicle usage defined in paragraph 213, that is, 40% of the potential demand for car travel by people working in the centre, or 26% of the *total number* of people employed in the centre, and larger proportions elsewhere in the city.

218. The primary network shown in Figure 125 comprises about 70 miles of road, about three quarters of which would be new roads mostly of motorway standards. The total cost of the network would be of the order of £90m. for land acquisition, clearance and construction.

124 Survey of existing network and traffic facilities.

125 The intermediate network.

The central area

219. We then examined the central area in more detail, with the object of determining the broad nature and scale of the changes required to enable it to deal with the traffic which the 'intermediate' network was capable of discharging.

220. The existing land uses within the central area are shown in Figure 126. Areas where substantial changes are likely to take place, and those which are unlikely to change, are shown in Figure 127. The central area extends over 240 acres.

Peak hour generation and parking

221. *Commuters.* The area under study contains about 60% of the floor space of the 'central zone' defined in connection with the foregoing traffic estimate. We assumed that the employment in the study area and the number of cars used for the work journey would be of the same proportion (60%). The number of persons coming to work by car could therefore be

126 The main uses in the central area.

Areas where substantial changes are likely to take place

Areas which are unlikely to change

Areas where existing character should be retained if and when redevelopment takes place

127 Opportunities for redevelopment in the central area.

128 Aerial view of the central area from the south-east.

129 An area worthy of preservation—Park Square.

130 Shopping arcades are characteristic of the central shopping area and are worthy of preservation.

about 16,000 in 11,500 cars, all needing parking space. It is estimated that they would create a peak hour flow, assuming present working hours are maintained, of about 8,000 p.c.u. per hour.*

222. *Shoppers.* Out of 67,000 daily shopping journeys into the central area from outside, we assumed that 64%, or 43,000 would eventually be made by car. With an occupancy rate of 1·3, this would result in 33,000 cars. Assuming a parking turnover of 5, then 6,600 spaces would be needed. Assuming 10% of the cars leave during the peak hour, the peak hour flow would be 3,300 p.c.u.

223. *Essential traffic.* We estimated that the total daily generation would eventually amount to 34,500 journeys, of which 11,500 would involve cars and the remainder vans and lorries. Some 2,000 parking spaces would be needed for the cars at a turnover of 6·0, and 3,600 spaces of various kinds for the others at a turnover of 6·5. Assuming 8% of these vehicles leave during the peak hour, the flow would be 3,675 p.c.u.

224. *Buses.* We estimated that approximately 775 buses would be needed at the peak hour to cater for workers and shoppers not using cars. This would be equivalent to an outward flow of 2,325 p.c.u. We allowed in addition an outward flow of 700 p.c.u. during the peak hour for other forms of traffic, such as visitors to public buildings, or places of entertainment.

225. *Total parking and peak hour generation.* The parking spaces required, and the maximum acceptable peak hour generation, are obtained by summation of the above figures. The totals are set out in Tables 4 and 5.

Table 4: Central area parking and loading requirements

Type of traffic	Number of parking spaces	Number of loading bays, and other resting spaces	Total
Commuters	11,500		
Shoppers	6,600		
Essential cars	2,000		
Essential vans and lorries		3,600	
Total	20,100	3,600	23,700

Table 5: Central area peak hour generation

Type of Traffic	Peak hour generation (p.c.u.)			
	Cars	Lorries	Buses	Total
Commuters	8,000			8,000
Shoppers	3,300			3,300
Essential	920	2,755		3,675
Buses			2,325	2,325
Other	700			700
Total	12,920	2,755	2,325	18,000

The central area network

226. *Primary distribution.* The primary distributors illustrated in Figure 131, serving the centre of Leeds, form a rectangle enclosing a greater area than the centre itself, but the northern distributor passes *through* the northern part of the central area. We think this is a case where the advantage lies in placing the road in a cutting with pedestrian links across it, with retaining walls suitably designed to reduce the noise. We propose that there should be six entry points or 'doors' from the primary distributors into the area which they enclose, three of which enter the central area itself.

227. *District distribution.* Our aim was to plan an internal system of district distributors which would cause as little disruption as possible to the centre.

* p.c.u., or passenger car units, is a measure of the volume of mixed types of vehicles in a traffic stream expressed in terms of the equivalent number of 'passenger cars', e.g., 1 bus = 3 p.c.u.

But the peak hour flows—an average of 3,000 p.c.u. at each interchange with the primary roads—inevitably mean large scale roads, 2 or 3 lanes wide in each direction. The only existing roads in the area capable of dealing with such flows are the shopping streets, but we rejected the idea of using them for the purpose. We therefore had to find new routes. These we have sited through the more obsolescent areas. They leave the broad 'functional zones' of the centre intact. Where the pedestrian system crosses these distributors, separation by levels would have to be contrived. The primary and district distributors and their interchanges would occupy about 22% of the central area, or 53 acres.

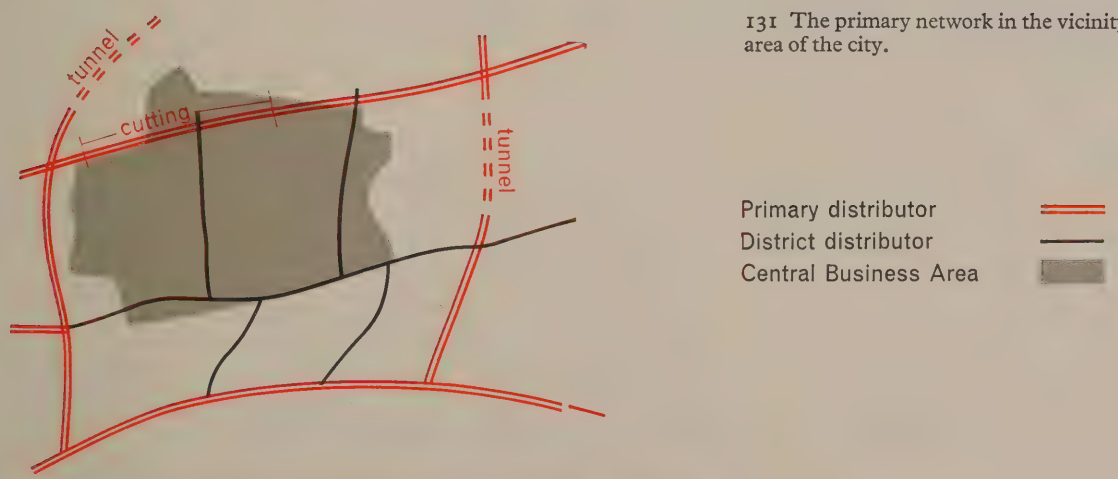
228. *Local distribution.* Before we could proceed to a layout, we had to decide on the extent to which 'optional' vehicles, and buses, should penetrate into the area. There were four possibilities:

(i) Provide long term and short term car parks for optional traffic off the *local* distributors (these roads to be used by buses as well). This would give a high level of accessibility. But heavy flows would result, necessitating new roads with consequent redevelopment, and a separate level for pedestrians.

(ii) As in (i) but confine buses to *district distributors*. Buses represent only 13% of the total peak hour flow, so there would still be a considerable amount of traffic on the local roads.

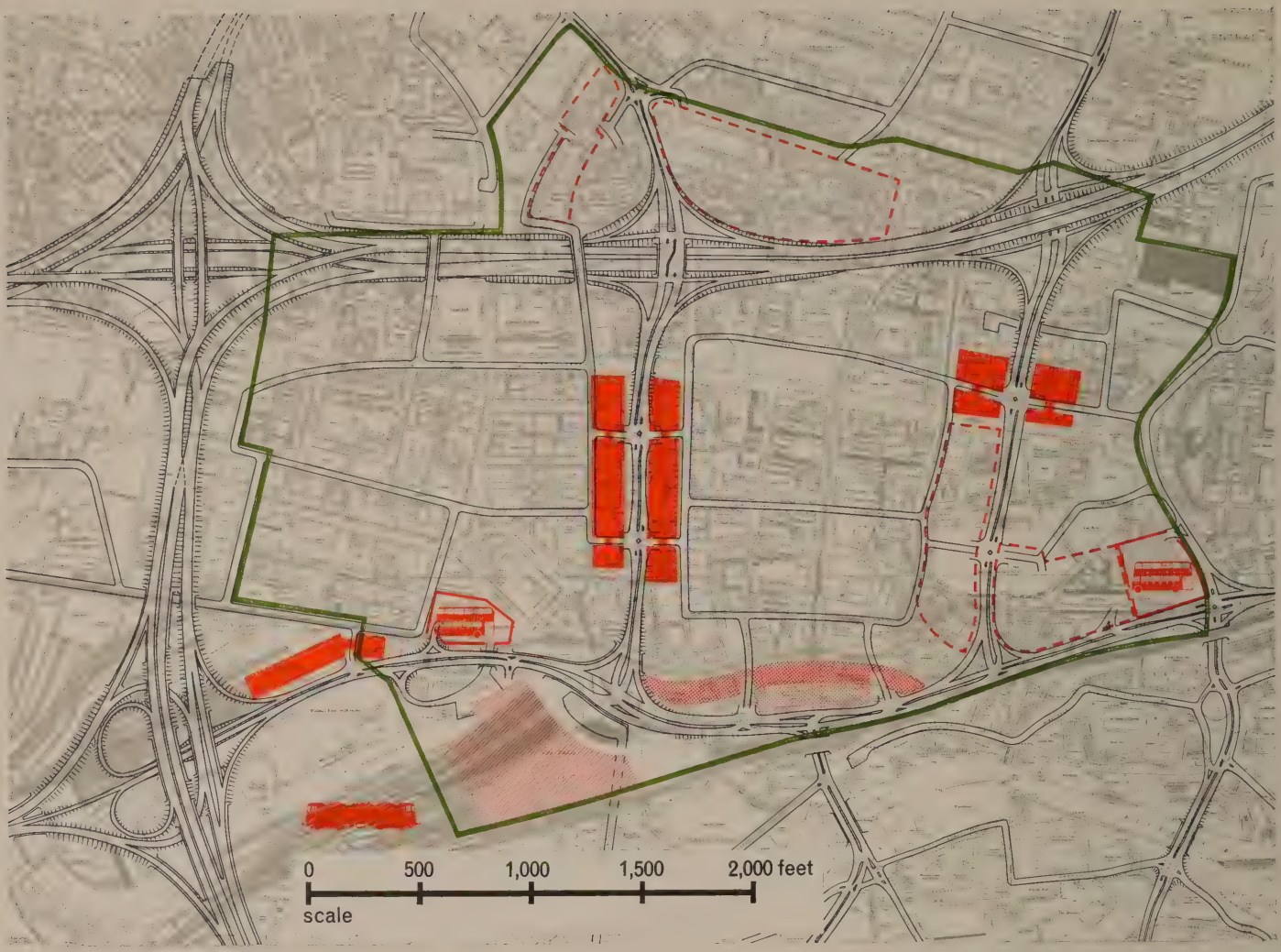
(iii) Provide long term and short term car parks for optional traffic off the *district* distributors, with buses confined to these roads as well. This reduces the flows very considerably on the local roads, redevelopment is kept to the minimum, but accessibility would be poor.

(iv) As in (iii) but buses routed along the local distributors, thus giving the people who opt to use this form of transport some advantage over others.



131 The primary network in the vicinity of the central area of the city.

132 The main shopping streets also serve as the main traffic thoroughfares (Briggate).



Boundary of Central Business Area

5 storey car parks

4 storey car parks over shops

One level car park over station

Surface car parks

Basement car parks one level

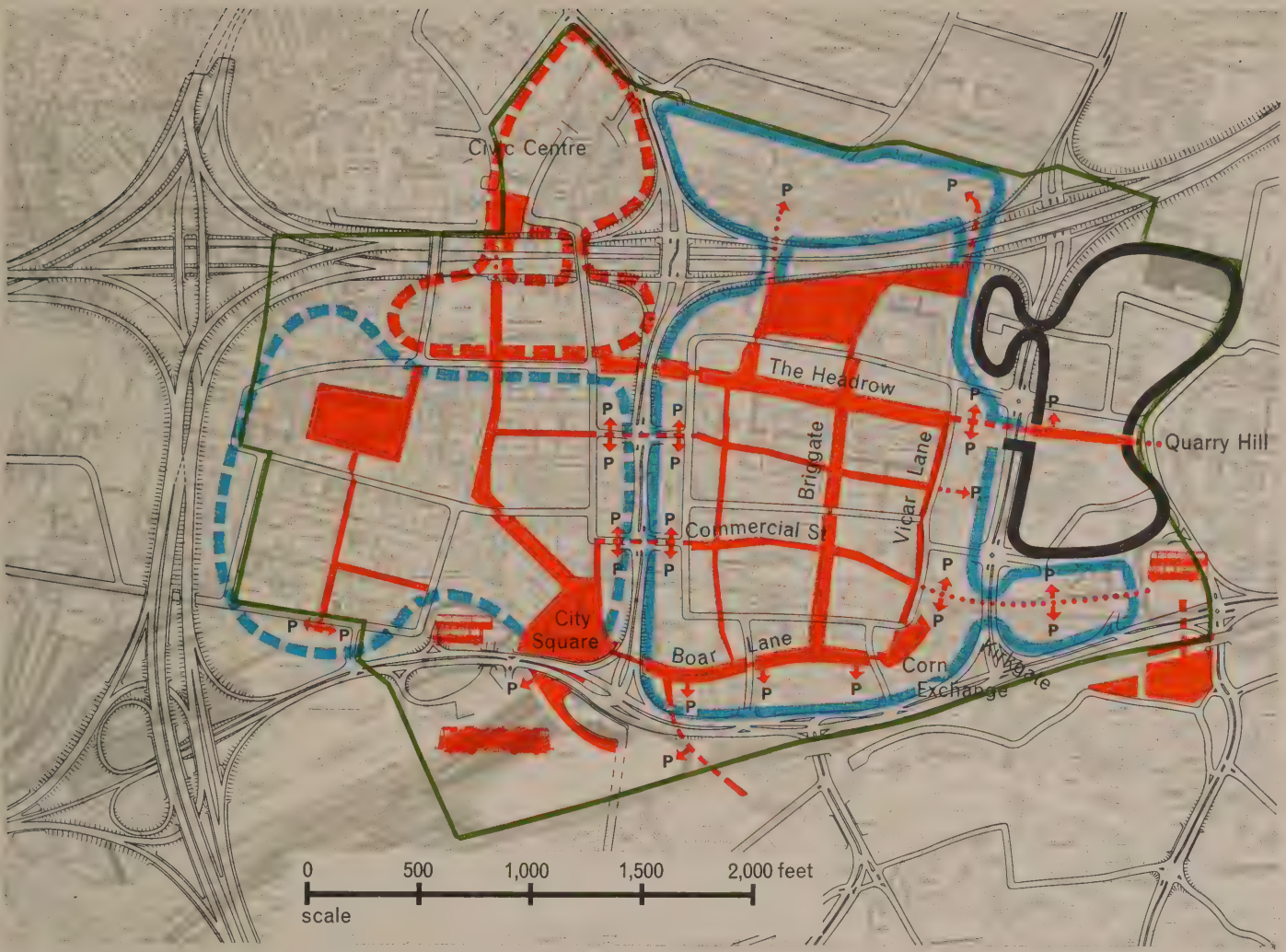
133 The central area network and car parking proposals.

The central area design

229. We decided to explore the last of these possibilities. The broad proposals are shown in Figures 133-134. The main feature is the creation of an extensive traffic-free shopping area comprising Headrow, Briggate, Commercial Street, Kirkgate and Boar Lane, with a pedestrian square in front of the Corn Exchange. The local distributors are based on existing roads with the exception of one new road which is needed to make possible the conversion of Boar Lane to a pedestrian shopping street. Comprehensive redevelopment of the south side of Boar Lane, as far as the railway, would be necessary. We have assumed ground level shops fronting onto Boar Lane, with servicing and some parking to the rear, and multi-storey parking accommodation above.

230. The opportunity presented by the construction of the new district distributor to the east of Vicar Lane could be used to create an upper level market and shopping area for pedestrians, stretching up to the east side of Vicar Lane, with bridges for pedestrians connecting, over the local road, with the ground-level pavement on the west side. A service area and bus station are placed underneath the upper level shopping area and market. Below these, again, and taking advantage of the fall of the ground eastwards, is one floor of car parking.

231. The areas adjoining the district distributor would need to be redeveloped comprehensively. In other respects, the proposals for local roads and pedestrian streets would allow for the gradual renewal of the main shopping centre. Nevertheless, in certain parts of the centre, the redevelopment of sites would have to take place on a fairly large scale to facilitate the 'back servicing' of buildings fronting onto pedestrian shopping streets. We estimate that 115 acres, or 48% of the central area would need to be redeveloped to achieve this plan. This includes land for roads and parking garages. The area affected is shown in Figure 135.



134 The central area design showing the integration of the primary and district distributors with the regrouped uses to form environmental areas. It also shows how the pedestrian system binds these areas together and links to car parks.

Boundary of Central Business Area

Pedestrian areas

Shopping

Industry and commerce

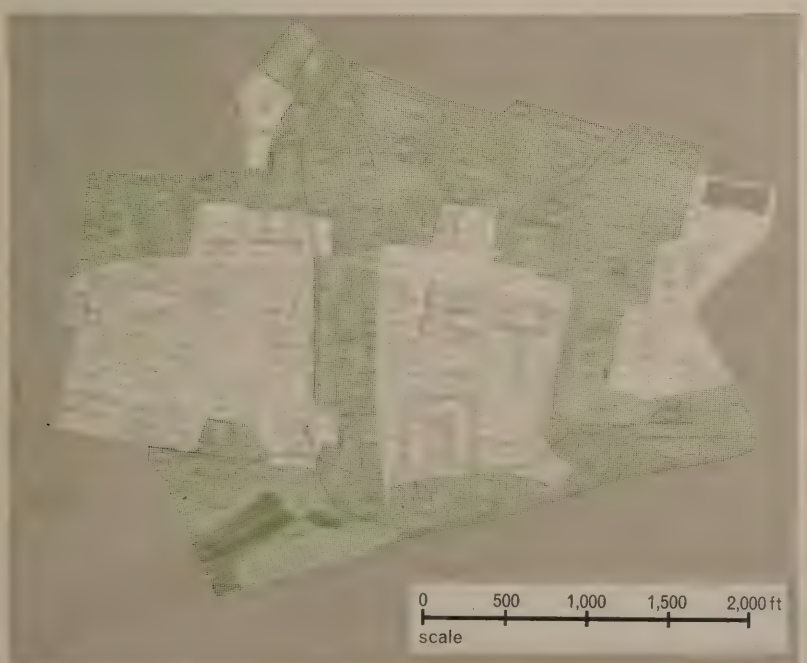
Civic centre and public buildings

Offices and commerce

Pedestrian access to car park →P

Subway

Bridge



135 Areas which would require redevelopment in order to permit the construction of the distributors, parking facilities, and conversion of certain streets to pedestrian use.

136 Location of Allerton and Headingley.

Environmental management

232. While we were considering the possible grouping of environmental areas, we found ourselves asking how such areas (particularly where the development is fairly new) could be established, and whether anything could be done to accelerate the process, or at least whether anything inexpensive could be done to improve local conditions to cope with the gradual increase of local traffic. This led us to examine two areas in detail. We concluded that there were indeed possibilities of devising a technique which could start the process of upgrading the environment. We have called this technique 'environmental management'. It should be distinguished from '*traffic management*', which is solely concerned with the movement of vehicles, and often at the expense of the environment, but it uses some of the same methods. We give below a brief account of the two studies. A more detailed discussion of the closely associated question of environmental standards will be found in Appendix 1.

The first study—Allerton

233. We first examined *Allerton*, a residential suburb having a population of 20,000 situated on the north-eastern outskirts of the city (Figure 138). It consists mainly of houses built between the wars in a collection of independent estates which together present little semblance of an overall plan. There are two secondary schools, a hospital, several small groups of shops, and a larger group of 32 shops in Street Lane. Two sizeable shopping centres on the periphery of the area, at Harrogate Road and Roundhay Road, help to serve the area. The area is more or less clearly defined by existing main roads which we have assumed will continue to serve as distributors, and falls into four environmental areas as shown.

234. Although many of the houses were built without garages, the density and layout are such that there is generally space for one to be provided. Erection of garages is now in progress, and is likely to go on until there is provision for at least one car per family. The steady growth of car ownership is showing itself in a marked increase of traffic within the area. The most pronounced movements of traffic are eastwards and westwards to and from the radials, and then south towards the city centre. There are

137 The process of realising the environmental areas could start with the closing of selected streets leading to the concentration of traffic onto the potential distributors. A new road would be required to remove traffic from the Street Lane shopping centre, and is shown by the broken black line.

Shopping

Boundaries of environmental groupings

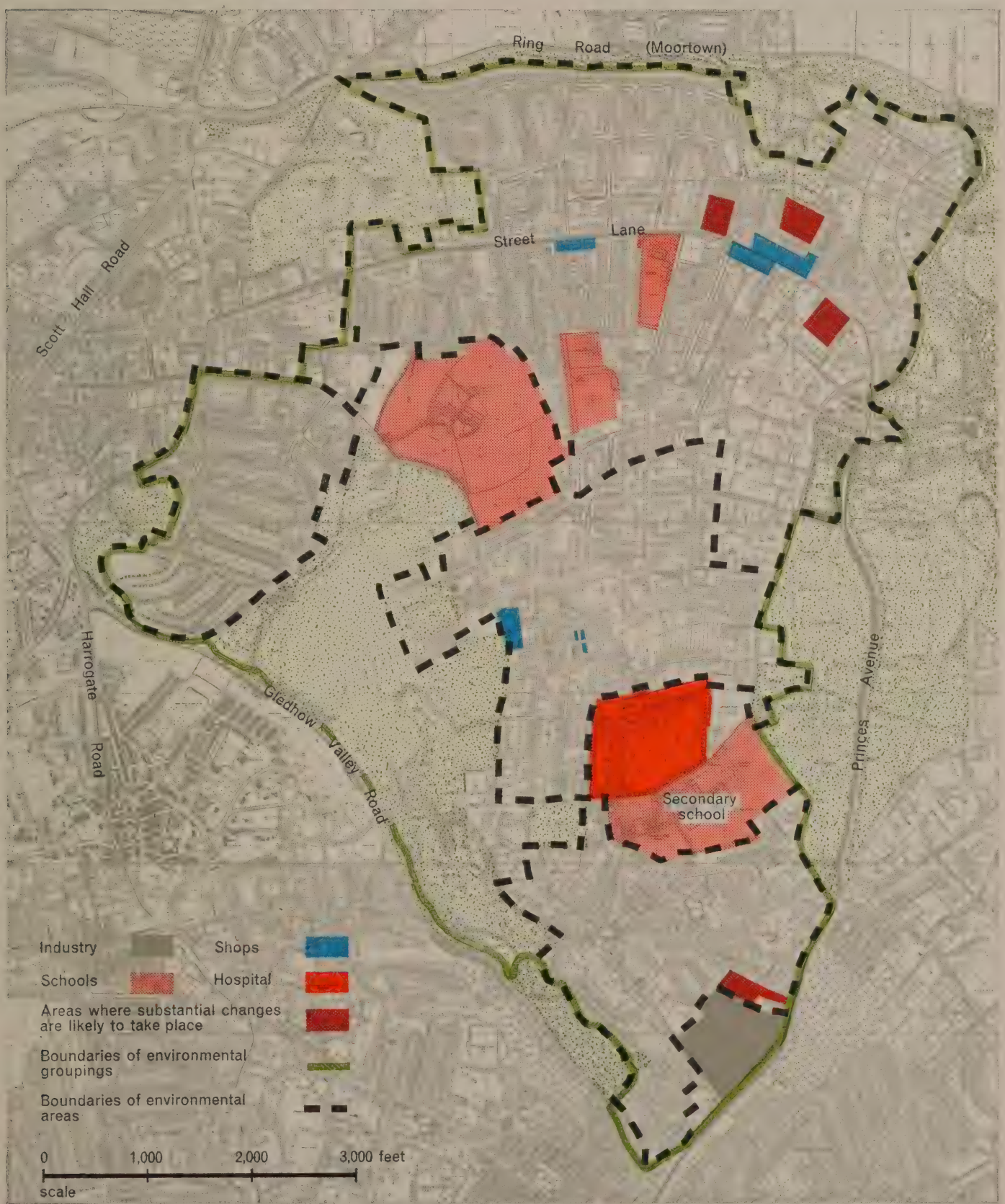
Boundaries of environmental areas

Existing streets terminated

at present no clearly defined patterns of flow, and traffic filters at-will through the internal streets to the detriment of the environment. It also happens that the busiest internal road (Street Lane) passes straight through the busiest of the local shopping centres.

235. In order that the traffic on the roads within the environmental areas does not build up beyond the environmental capacities, we have selected certain roads outside these areas to function as distributors. We have then interrupted the continuity of the access roads within the areas in order to canalise movement onto these distributors. This also limits the number

138 Environmental appreciation of Allerton.



139 Otley Road is a main radial road of the city which passes right through the Headingley shopping centre, where a major environmental conflict arises.

of junctions on the distributors and improves their standard of performance. Through movements of traffic across the area as a whole are either prevented by the physical stopping-up of streets at the points indicated, or made inconvenient for use by vehicles on longer journeys. Pedestrian and pedal cycle movements would be unimpeded by environmental boundaries.

236. In the near future, one substantial physical alteration would be required to deal with the conflict of interests at the shopping centre on Street Lane. Here there is quite a substantial concentration of shops, so we looked for ways of closing Street Lane at this point to through traffic in order to bring about a safer environment. This could be done by a short length of new road as shown by the broken line, Figure 137. This would require some redevelopment to allow car parking facilities to be provided. It would also require the adaptation of the shopping centre for pedestrian movement only.

The second study—Headingley

237. The other area considered was Headingley, some two miles north-west of the city centre. By contrast with the haphazard development of Allerton, *Headingley* has a clear plan with a large and well-established centre, including about one hundred shops, five banks, and a parish church. Originally Headingley was a village on the main road to Otley and Ilkley, but in Victorian times it developed as a suburb of Leeds. The development was of two kinds. On the north-east side of the Otley Road, an area was developed of large houses with substantial gardens. On the south-west side, development tended to be of small terraced houses, and has now been consolidated with suburban semi-detached houses. The old village became, and remains, a good-quality shopping centre.

238. We confined our study to the area of small houses lying between Otley Road and the railway line to the south-west. It has a population of 8,000 and is bordered to the north by St. Anne's Road, and extends southwards to include Chapel Lane. The low density part of Headingley was excluded because the environmental problems there (if any) are less urgent

140 Environmental appreciation of Headingley.

than elsewhere. Figure 140 shows the boundaries of the area, the focal points of local movement, and a sub-division into possible environmental areas.

239. Local traffic movements are concentrated on the Otley Road. This is a main radial road of the city which also serves numerous offshoots into adjoining suburban areas, of which Headingley is one. It passes right through the Headingley shopping centre, where its traffic produces a major environmental conflict.

240. In addition to locally generated traffic, the area is adversely affected by substantial cross-flows of traffic filtering through in various directions. One of the causes of this filtration is that drivers are seeking to avoid the congestion on the Otley Road where it passes through the Headingley shopping centre. Another is the existence of a bridge over the railway at Kirkstall Lane which attracts traffic through Headingley—much of it through the shopping centre. The location of the county cricket and rugby football grounds in the area also has a drastic, though intermittent, effect, when the locality is invaded by spectators from all directions.

241. Figure 142 shows some ideas for environmental management on similar lines to the Allerton area. Headingley is a compact area, where walking to local shops and schools can be expected to remain an important means of movement. In addition to making pedestrian movements safer an important object of environmental management would be to encourage more pedestrian movements by the creation of a footpath system serving the school and the shopping area. The suggestions we make would not produce the high level of environmental conditions which could be achieved in areas of new housing development, but they would affect a notable improvement by sorting out the present mixture of pedestrian and vehicular movements.

141 Existing roads, mainly through residential areas, used as 'filtration routes' for traffic seeking to avoid the congestion in the shopping centre.

142 Some possible immediate steps in environmental management for the Headingley area, including a by-pass to the shopping centre. Otley Road and Headingley Lane are retained for the time being as a primary distributor.

143 The Headingley area as it might relate to the fully developed network.

242. In outlining these ideas we have had to pre-suppose the temporary adaptation of the Otley Road as a primary distributor, with a by-pass to the Headingley shopping centre to be converted later into a service road for the shops. This would be absolutely essential for the up-grading of the environment of the shopping centre. Also, in order to eliminate through traffic in Kirkstall Lane, it would be necessary to extend St. Anne's Road to the railway bridge (as proposed in the development plan). The frontage development in St. Anne's Road makes it unsuitable as a distributor road, and we have shown a new line slightly further south. This coincides with the boundary of an environmental area. Given these two capital works, it would be possible to make a serious start with the environmental management of the area. West of the railway a new radial distributor (which is one of the links appearing in our main network study) would in due course enable proper access to be provided to the football and cricket grounds. Figure 143 shows the manner in which the Headingley area would relate to the fully-developed primary network.

243. New traffic access to the Headingley shopping area could be facilitated by some redevelopment to provide rear servicing for goods deliveries and customers' car parking. The shopping centre itself is shown converted to pedestrian use only. There is in fact scope for several quite different arrangements whereby pedestrian and vehicle movements can be separated, depending on the amount of redevelopment envisaged and the routes which bus services use to approach the centre. Lastly it will be seen that the ideas set out provide for the development of an independent network of pedestrian ways leading to the shopping area. The area as a whole is compact enough for this kind of pedestrian movement to be provided for.

244. We do not suggest that environmental management can always be started without some expenditure on capital works. This is demonstrated by the Headingley example, but there will be very many areas where, given modest expenditure, a real start could be made on squeezing out the extraneous traffic onto potential distributor roads, and re-organising internal circulations in order to reduce the impact of traffic as it has now developed, and as it is getting worse every day. We think there is a promising technique here which would repay further study and development.

Conclusion

245. This study of Leeds demonstrates three main points. First it shows that the problems of vehicular movement, even in a complex city, are susceptible to analysis. There is no need to proceed by guesswork or hunch. The necessary characteristics of a network are almost as capable of methodical evaluation as the layout and dimensions of a steel frame for a building. The methods described in this chapter are comparatively crude, but given the time and resources a very reliable prognosis could have been made. *Secondly* the study shows the very formidable potential build-up of traffic as vehicular ownership and usage increase to the maximum. The accommodation of the full potential is almost certainly beyond any practical possibility of being realised. There is thus no escaping the need to consider to what extent and by what means the full potential is to be curtailed. It seems to us that the restraint is bound to fall primarily on the use of the private car for travelling to work, and this has vitally important implications for public transport. But even granted a restraint, the basic essential traffic and the residual optional traffic which the public seems likely to demand, will require difficult and costly measures. *Thirdly*, the build-up of traffic is likely to have profound consequences for the central area, necessitating substantial redevelopment, in order to obtain satisfactory accessibility and good environment.

144 The regional setting of Norwich.

Part three : A historic town

246. There are many cities in Britain where the traffic problem is given a further twist by the fact that the old centre has a historic and architectural character which, if it is to be conserved, prevents major reconstruction. We thought it would be instructive to study one of these cities. We chose *Norwich* for the purpose. We acknowledge at the outset the great help given us by the Norwich Society who, at our request, made an environmental appreciation of the centre. We are also grateful to the City Engineer for placing survey data at our disposal. We wish to make it quite clear that this study is in no sense put forward as a plan for Norwich. It is an academic study which perhaps suggests a new way of looking at a difficult problem.

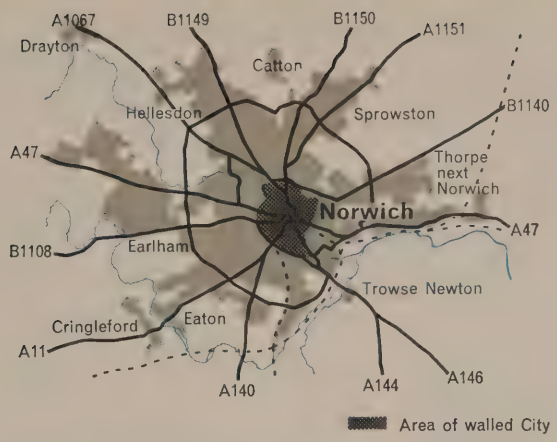
Present conditions

Description of the city

247. Norwich is a free-standing cathedral city in an agricultural countryside, and is unrivalled in its dominance of East Anglia. (Figure 144). The population is about 160,000, and is expected to increase to 175,000 during the next 20 years, and may eventually reach 200,000. Figure 146 shows the broad extent of development, with the historic centre and a dozen or so main radial roads.

248. The main land uses within the *historic centre* are shown in Figure 147.

145 The buildings in the old city reflect its centuries of history. The Castle is finely situated on a mound.



146 General plan of Norwich showing the existing road system and the walled city.

147 Land uses within the historic centre.

The area is roughly a mile across, and is enclosed on three sides by the old city wall, and on the fourth by the River Wensum. Traditionally, there is a considerable intermingling of different kinds of uses within the old city. But certain main groups can be identified, such as the two concentrations of industrial uses along the River Wensum, the group of civic buildings around the City Hall, the ecclesiastical area around the Cathedral, and the main shopping centre extending from St. Stephen Street through the Market Place to London Street and Prince of Wales Road.

249. The main professional, business and administrative activities of Norwich are now concentrated in the old city, together with a large part of the City's manufacturing industry. Much of the former residential use has been displaced, and people have moved out to the suburbs. It is estimated that there are 30,000 to 35,000 persons employed in the old city area, out of a total of 88,000 employed within the Norwich labour exchange area.

250. Norwich has had borough status for over a thousand years. The buildings in the old city reflect these centuries of history. There is the Cathedral, the Castle finely situated on a mound, and the modern City Hall. There are more than thirty mediaeval churches of great interest, the Guildhall, and the remains of the old city wall. Altogether, in the small area of the old city, there are 400 buildings or groups of buildings which have been listed under the Town and Country Planning Act as being of historic or architectural interest. The location of these buildings is shown in Figure 149. Although the buildings are scattered throughout the old city, there are a number of important groups, and in particular there is a unified area comprising the Cathedral, the Close, Tombland, St. Andrew's Plain, Elm Hill and Palace Street where much of the old city remains intact. The mediaeval street pattern is itself an important part of the City's history. It is complementary to the buildings in scale and provides their setting.

251. There are also many lengths of building frontage which, while not necessarily including historic buildings, are important to the urban scene and worthy of protection. The more important of these are also shown in Figure 149.

Vehicular traffic

252. As might be expected in a busy city whose centre functions largely on a mediaeval street pattern, vehicular movement is restricted by congestion. No less than twelve busy roads converge on Norwich, funnelling traffic towards the centre. The traffic on these roads is mainly destined for Norwich, but in summer there is a higher proportion of through traffic than at other times of the year (24·5% at a count taken in 1957) caused by vehicles bound for the holiday resorts along the Norfolk coast. Even so, the traffic converging on the centre from outside the town is small in quantity compared with that from inside.

253. A recent survey of traffic in and around the city centre indicated that the number of vehicles entering the old city area on a weekday (Friday) between 7 a.m. and 7 p.m. was about 43,000, and during the same period on a Saturday the number was about 49,000.

254. During the Friday morning count, the number of cars entering the old city area between 7.45 a.m. and 9.45 a.m. was 6,687 and the number leaving was 2,933. This provides a rough pointer to the number of people using cars for the journey to work into the centre. It is estimated that nearly 20% of the employees in the area already travel by private transport.

255. A survey of car parking in 1960, covering an area somewhat less than the walled city, showed that 3,500 vehicles were parked (on and off the streets) during the peak Friday morning period. This figure represents an increase of 38% over a similar count two years earlier. It is estimated that a comparable figure for the walled city as a whole would now be over 5,000 vehicles.

148 Elm Hill. Although historic buildings are scattered throughout the old city, there are a number of important groups, and in particular there is a whole area west of the Cathedral where much of the old city remains intact.

149 Buildings of historic or architectural interest, and street frontages important to the urban scene.

150 The street pattern was evolved at a time when most movements in towns were made on foot. Many pedestrian ways still remain.

151 The very narrowness of the streets forces pedestrians and vehicles into close proximity to each other.

256. The traffic flows at twenty entry points into the old city area duri i ; the period 5.15 to 6.15 p.m., also on the Friday, are shown in Figure 152. The precise manner in which this traffic is dispersed within the old city area is not yet available from the survey, but it seems clear that old narrow thoroughfares such as St. Giles Street, St. Benedict Street and Magdalen Street are taking major flows, as also are the widened shopping streets, Red Lion Street and Prince of Wales Road. Congestion is sufficient to induce traffic to filter through whichever streets promise the shortest journey-time. Consequently the whole street network within the old city is at times used to its maximum traffic capacity.

Pedestrian movement

257. The scale of the old city is small and essentially suited to the pedestrian. The area is only about a mile in width. The street pattern was evolved at a time when most movements in towns were made on foot. There is still a great deal of pedestrian movement, but the pattern has changed with the changes in land use. The bus station, for example, is now probably the largest single generator of pedestrian movement in the whole central area.

258. The main pedestrian movements take place between points of arrival by vehicle (Thorpe Station, the bus station, four or five central bus stops and the car parks) and the central shopping and employment zones. In addition there is a certain amount of pedestrian movement into the central area from nearby residential areas. The main concentrations of these pedestrian movements are in the vicinity of the Market Place, and about the central shopping streets.

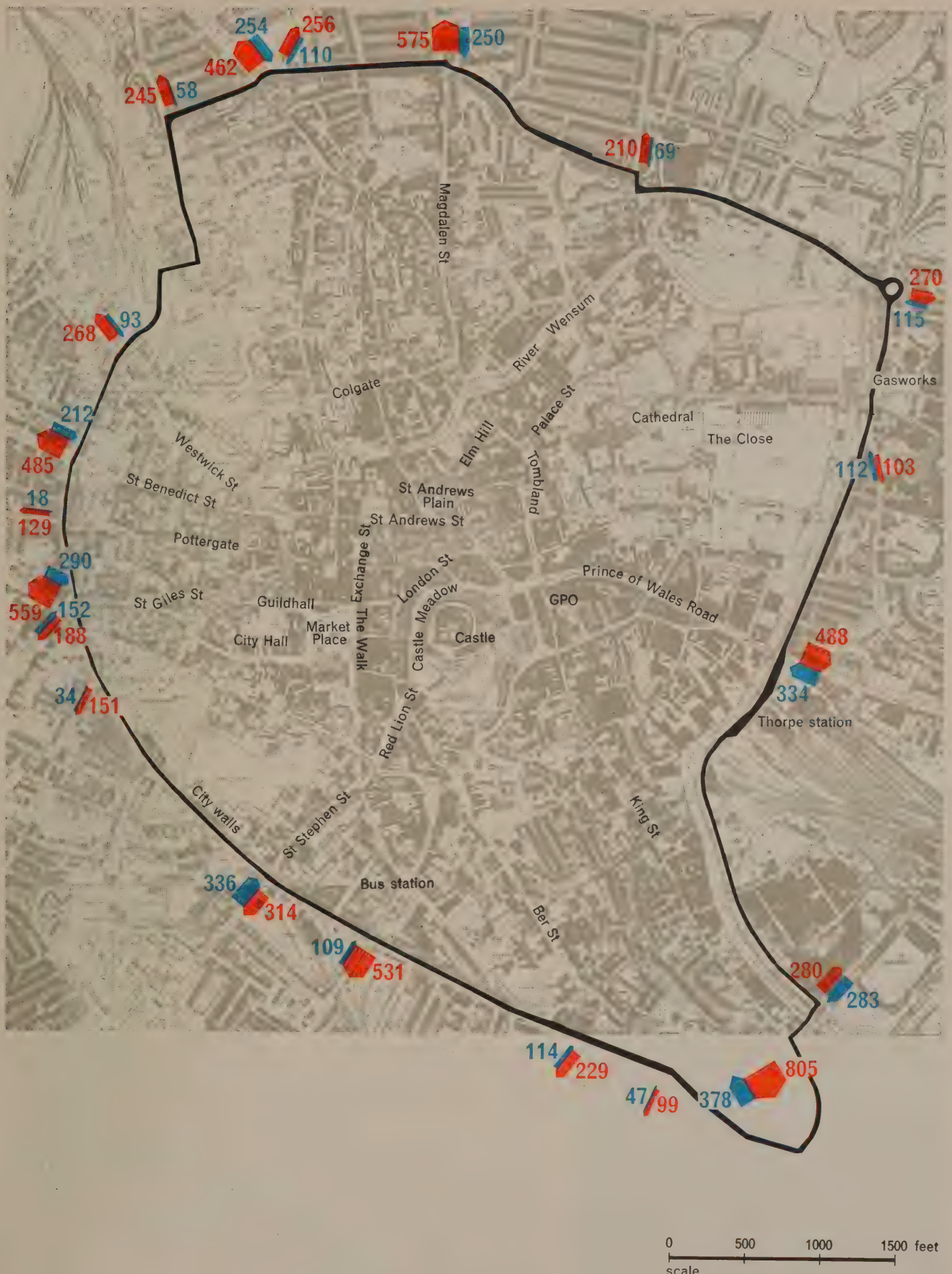
Traffic and environment

259. It follows from what has been said about the historic buildings and street pattern, that Norwich is a city that could have an exceptionally high standard of environment, using that term in both its special and general sense. The street scenes are inherently attractive in scale and quality. There are numerous pleasant walks, as well as the special amenities provided by the River, the Castle and the Cathedral.

260. This potentially high standard of environment is, however, lowered by the effect which vehicular traffic is having upon it. Although in most town centres traffic causes danger, noise and confusion, in Norwich these effects are more pronounced because the very narrowness of the streets forces pedestrians and vehicles into closer proximity to each other, and because moving vehicles come closer to the buildings where people are living or working.

261. The unity of the central part of the area from the Cathedral westwards, where the mediaeval street pattern is still intact, and where many historic buildings are concentrated, is severed by heavy cross-flows of traffic. This is particularly the case at Tombland and St. Andrew's Plain. Narrow shopping streets such as Magdalen Street and St. Benedict Street, which are essentially domestic in character, are also functioning as major traffic routes. In fact there are four radial routes converging into Magdalen Street. London Street and Exchange Street, which are part of the central shopping area, also form part of the present main road network despite their narrowness and use for shopping. Measures to assist the flow of traffic by the widening of central shopping streets only introduce a new element of danger for shoppers, and change the original character of the street. This has taken place, for example, in Red Lion Street.

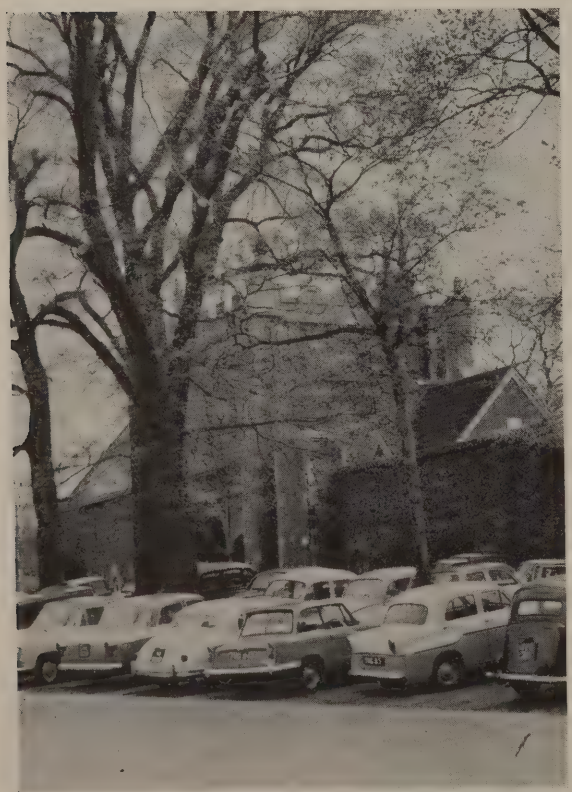
262. It is inevitable in the present conditions that there is a severe conflict between pedestrians and vehicles throughout this tightly packed central area. It is most marked at points where the main pedestrian movements cross heavy traffic flows. Nowhere is this more in evidence than in The Walk where pedestrians cross in great numbers between the market and the main shops, and hardly less so at the Head Post Office, in Castle Meadow, and at points between the bus station and the centre. The



152 Traffic flows, in vehicles per hour, at the entry points to the old city during the evening peak.

153 Narrow shopping streets, which are essentially domestic in character, are also functioning as major traffic routes.

154 There is a severe conflict between pedestrians and vehicles throughout the central area.



155 Every accessible space is taken up by cars. The Gate to the Bishop's Palace.

environmental conditions deteriorate as the number of vehicles increases, and this is reflected in the increase in road casualties, which in Norwich rose from 502 in 1957 to 644 in 1962.

263. Furthermore, with the present level of car parking, every accessible piece of ground is taken up by cars. This takes place regardless of local amenity. Places of great interest and beauty such as the precincts of the Cathedral and the Castle, Tombland and St. Andrew's Plain are packed with cars with grave detriment to their appearance.

Traffic and accessibility

264. Just as the standard of environment in the centre of Norwich suffers from too much traffic using the ancient street network, so accessibility to the buildings suffers likewise. Because of the narrowness of the carriageways in many of the streets, a stationary vehicle can impede the flow of traffic in the whole street. Conversely, regulations designed to keep traffic moving often frustrate direct access to individual premises.

265. The concentration of industrial buildings in the vicinity of the River Wensum is largely served by the old street network. This causes heavy vehicles to use the central shopping streets. As the industrial and commercial firms expand so the accessibility problem is aggravated. In the area around Magdalen Street and Colegate, for example, the residential uses become less common, whilst the volume of locally generated industrial traffic grows and chokes the local streets. An air of incongruity and isolation attaches to those historic buildings that remain. For example, Pottergate, despite its extreme narrowness, has become the main access road for many modern commercial premises.

266. The shortage of space for car parking is acute and increasing month by month. Yet to provide additional car parking facilities in the centre would be the surest way of increasing the amount of traffic using the already congested streets.

The present position summarised

267. In brief then, with the present level of traffic and the present arrangement of streets and buildings, the environmental capacity of much of the old city is already grossly exceeded.

268. Any general policy of widening the existing streets to cope with more traffic must be ruled out because this would certainly destroy the historic character of the city. Already there is evidence to this effect in St. Stephen Street. It would be unthinkable to widen in this way St. Benedict Street, St. Andrew Street, Magdalen Street, St. Giles Street, London Street or many others. Similarly, to remove large numbers of buildings in the centre to make way for car parks would destroy the traditional compactness, and encourage more vehicles into the area.

The basis for planning

269. We could seek to do no more in this study than to consider the broad principles upon which the traffic and planning problems of a historic area might be tackled. The main principle is abundantly clear—if the environment is sacrosanct, and if no major reconstruction can be undertaken, then accessibility *must* be limited. There can be no question about this. Once this simple truth is recognised for areas of this kind, and futile attempts to cater for the whole future demands of traffic are put aside, then planning can be started on a realistic basis. It becomes a matter of deciding what level of accessibility can be provided and how it can be arranged, and then it is a question of public relations to ensure that the position is clearly understood.

The potential increase of traffic

270. Granted a threefold increase in the number of cars in the Norwich area by the year 2010, and assuming no restraints are operating, then it is

estimated that the number of *vehicles* seeking to enter the old city daily, exclusive of through traffic, would increase to about 76,000 by 2010. Of these 18,000 would be commuters' cars, 22,000 would be shoppers' cars or cars used for other private trips, together with about 200 buses and 36,000 vehicles connected with industry and commerce. The total peak hour flow would be of the order of 19,000 vehicles per hour, of which about 75% would be commuters' cars. The ultimate parking demand for this level of traffic would be about 25,000 spaces, including about 5,000 short term public spaces and 18,000 long term spaces for commuters.*

A problem of environmental management

271. The problem resolves itself into an exercise in environmental management on a big scale, with the whole of the old city forming one potential environmental area. The steps required to establish an environmental area are as follows:

(i) Numbers, types and speeds of vehicles to be kept down to a level compatible with environmental standards.

(ii) Circulation of essential traffic to destinations to be contrived, but not necessarily by the shortest route nor even with any choice of route.

(iii) Streets and areas which are used predominantly by pedestrians to be converted for pedestrian use only.

(iv) All through movements to be prevented.

(v) Internal movements to be reorganised to eliminate the conflict of criss-cross journeys.

272. In the particular case under discussion, the following additional measures would probably also be needed:

(i) Control to be exercised over change of land use within the walled city, with the object of reducing traffic generation. As a corollary, certain parts of the old city (e.g. Magdalen Street area, Ber Street area, Cowhill area, and parts in the vicinity of the Cathedral) might be retained for residential use. The purpose of this would not only be to restrain traffic generation, but also to maintain certain essential qualities of the historic city. In practice this would mean a reversal of the trend whereby houses are being replaced by industrial and commercial (as distinct from office) uses. This objective need not be in conflict with the function of the central shopping and administrative area. In fact it could well be to its advantage.

(ii) Parking policy, especially as to the amount and location of parking space, to be firmly directed towards the environmental objectives.

(iii) Public service vehicles might be given preference within the old city, if necessary they might be allowed to traverse areas from which other vehicles are excluded. Buses, too, might be adapted to the conditions of the old city—the use of smaller, quieter, slower-moving buses would be an advantage.

(iv) The question of traffic speed should also be considered. At present speeds are 'naturally' restrained for much of the time by congestion, but when congestion eases off then 30 m.p.h. becomes legally possible. Yet, on any count, a speed of 30 m.p.h. is too great at any time in any part of the old city. Public opinion might not be prepared for a move in this direction at the present time, but we think this is an example of the severity of discipline which is likely to be required in the future.

The primary network

273. In the normal way it would not be good practice to consider the central area of a town in isolation from the rest of the built-up area. In a case such as the present, however, the centre is so distinctive, so clearly demarcated from the rest of the city, and the environmental requirements so exacting that separate consideration of its distribution system is permissible. Even so we would have wished, had we had the opportunity, to have made a full study of the whole-town primary network. As it was,

* It should be understood that these figures relate not only to the normal 'central area uses' of the city, but also to a main concentration of industry.

156 Much of the setting of the Castle is used for car parking.

157 Just as the standard of environment suffers from too much traffic using the ancient street network, so accessibility to the buildings suffers likewise.

158 Parked vehicles in Tombland.

159 Even the forecourt of the Cathedral is used for parking cars.

160 Cow Hill. Certain parts of the old city might well be retained for residential use.

we had to make some working assumptions. In particular, we assumed that a primary distributor road would be located in the vicinity of the old city wall. Some such proposal is in fact embodied in the statutory development plan.

274. We then considered whether there would be any possibility at all of extending any part of the primary network into the old city without doing irreparable damage, because any such measure would greatly assist access to the central shopping and office areas. It would also enable local circulations to be rearranged in such a way that a great deal of the traffic which would otherwise be filtering through the old street network could be drained off, thereby helping to reduce internal traffic flows to an acceptable level.

275. To explore the possibilities we made an analysis of the land uses in the centre and found that it could be divided into 10 sub-areas each having a broadly homogeneous character (Figure 161). The severance of these areas by heavy traffic flows would be extremely detrimental to the environment. Most of these sub-areas have strong ties with each other. There is an almost complete absence of physical breaks between them and there are so many buildings worth preserving that the possibilities of inserting a major distributor are severely limited. We concluded that the only feasible line was across the south-eastern quarter. This would involve some sacrifice, but the area seems committed to extensive redevelopment and has lost much of its unity with the rest of the historic city.

276. Another possibility we considered was the insertion of an east-west link, roughly along the line of the River Wensum, to serve the industrial concentration. There were arguments for and against this, but we decided to reject it because a major road on this line would break the unity that exists between Magdalen Street and the rest of the city. We had no hesitation in rejecting absolutely any idea of a north-south link which would sever the mediaeval city stretching westwards from the Cathedral.

Siting the 'barriers'

277. We were now face to face with the environmental management problem. We had, as it were, brought the traffic to the several 'gates' of the old city. How much could now be admitted and through which gates? And how could cross-penetration all over the area be prevented? The answer appeared to lie in devising 'barriers' to cross-movement which would have the effect of breaking down the whole area into sub-units, each with gates to the network, but without direct connection to each other. The crucial matter to decide was where to place the barriers and how many would be required to have the desired effect.

278. To answer these questions it was necessary to understand the traffic-desires as they would be likely to arise, irrespective of restraints, within the old city when vehicle ownership approaches the maximum. We started with the known present-day peak hour flows of each kind of vehicle into and out of the area. We separated these flows between through traffic and local traffic, and also between usage for industry, business, travelling to work, shopping and other private uses. We then applied 'growth factors' to each in turn. We assumed that commuters' cars (in the absence of any major discouragement) would increase by nearly 4 times, carrying almost 70% of the working population instead of about 20% as at present, with a slightly lower number of persons per car; that shopping and other private traffic would increase by about 3 times; and that commercial and business traffic would be about $2\frac{2}{3}$ times the present-day level.

279. We were able to trace where, and in what proportions, this traffic would be generated within the old city by analysing the characteristics of nine of the ten sub-divisions previously made (the tenth being the cathedral close which is not normally a significant traffic generator). We made broad estimates of the number of jobs in each zone, and sub-divided the total generation of work journey movements and 'essential' movements in proportion. Similarly, the generation of shopping and other private movements was sub-divided in proportion to estimates of the shopping floor area in each zone. Table 6 shows the estimated peak hour generation allotted to each zone.

Table 6: Peak hour generation in each zone (p.c.u.)

Element of Traffic	Zone Number:									Total
	1	2	3	4	5	6	7	8	9	
'Essential' Industrial Commercial and Business	300	250	505	505	405	405	250	150	655	3,425
'Commuter' Work Journey by car	1,130	790	2,200	1,590	1,820	1,820	790	840	2,720	13,700
'Shopping' and other trips by car	220	nil	365	nil	290	730	nil	75	510	2,190
TOTALS	1,650	1,040	3,070	2,095	2,515	2,955	1,040	1,065	3,885	19,315

161. The centre divided into 10 sub-areas, each having a broadly homogeneous character. These sub-divisions are used in the analysis of traffic movements.

280. We assumed that the traffic associated with the nine zones would disperse in six general directions, and that the *proportion* of all traffic moving in each direction would be much the same as it is now. It was then possible to trace the paths of the various groups of traffic under *two sets of conditions*, assuming in both cases the existence of the primary network previously described, and the existence of the additional link across the south-east quarter of the old city:

(i) That there would be freedom of passage all through the existing streets of the old city, with connections on all sides to the primary network.

(ii) That the old city would be divided (as far as traffic circulation is concerned) into self-contained units, roughly equivalent to the nine zones previously selected, *each unit being independently connected to the network.*

281. In the first set of conditions (freedom of movement throughout the old city) we made 'traffic assignments' to each possible route, taking into account whether people, faced with a free choice, would proceed direct to their destinations via the city streets, or go round the primary network for part of the journey. In practice the choice would be influenced by many considerations, but the main one is duration of journey-time.

282. These assignments showed conclusively that if traffic were allowed to filter at will through the area, the demand for road space near the centre would be far in excess (about 50%) of the actual physical capacity of the streets, and many times the 'environmental capacity'.

283. We then investigated the second set of conditions in which the driver has no alternative but to proceed direct to or from the zone of his choice via the primary network. We concluded that it would not be necessary to accept the rigid division into nine zones, but that a minimum of four main groups would suffice, with two main barriers to cross-movement. The first barrier would be on an east-west line roughly along the line of the River Wensum. This would have the advantage, *inter alia*, of preventing traffic generated in the predominantly industrial area from penetrating into the old street network of the historic city. The location of the second barrier, which would be required on a north-south line, is more difficult to determine because there is no natural line to follow. But a barrier roughly from St. Georges Bridge on the Wensum to Ber Street to the south would allow a reasonably good internal circulation system to be formed out of the existing streets, with fairly evenly balanced loads as far as the primary network is concerned.

284. The four main groups and the two barriers are shown in Figure 162. These are illustrations of principles only. In practice much detailed study, accompanied perhaps by full-scale experiments, would be required of traffic behaviour, and of the possible social consequences of the barriers, before final decisions could be taken. It is possible, moreover, that some further breakdown of the four main groups would be required to deal with conditions at certain localities.

285. It should perhaps be emphasised that by 'barriers' we do mean a physical stopping off of streets to prevent the passage of vehicles (with the possible exception of buses), though not, of course, of pedestrians or cyclists. We do mean literally the closing to traffic of the bridges over the Wensum except towards the west where the barrier would lie south of the industrial area. The concept, in effect, is to convert the old city into four 'rooms' each with its 'doors' from a new external corridor system, instead of each room being in direct communication with the next through a multitude of doors. If this seems a startling concept we can only observe that a policy somewhat on these lines, with the discipline it will involve for motor traffic, seems to be the only way of saving the old city from a descent into such chaos that eventually an irresistible demand will arise for it to be swept away.

Car parking

286. Complementary to the policy of 'barriers', it would be essential to reduce to a minimum the amount of parking space (especially for car commuters) served directly off the old street network within the old city. The major car parks should be on the fringe of the old city served directly off the primary network. Whether it would be possible to meet the whole ultimate demand for parking space (estimated at 25,000 spaces by the year 2010) would, of course, depend on the ability of any primary whole-town network to handle the flows. This we have not fully investigated.

Pedestrian areas

287. It should be possible, with measures on the lines we have suggested, to reduce the volume of traffic in the existing streets to levels that would give a reasonable standard of environment. Certain shopping streets and places where people congregate should, however, be freed of traffic. We think it would be possible, with the traffic circulation pattern we have suggested, to remove traffic completely from The Walk. We also think that London Street and other principal shopping streets in the neighbourhood should be closed to traffic during certain times of the day, as is now the practice in many continental cities, and that this procedure might form part of the scheme for breaking the east-west traffic flows. The introduction of service trolleys might play a useful part in helping shops to meet the problems arising from a policy of this kind.

Conclusion

288. The retention of old historic areas and areas of special architectural interest is dependent upon the maintenance of satisfactory environmental standards. There would be no point in seeking to retain such areas except in conditions in which they could be savoured and enjoyed.

289. We think this exercise demonstrates that these areas can be retained in the age of the motor vehicle provided a reduced standard of accessibility is accepted, including a strict discipline of vehicular movement.

162 The breakdown of the old city into four main areas or 'rooms'. There would be freedom for pedestrians and cyclists and some bus services to move from area to area, but for other traffic the approach to the areas would be via the primary network. In practice the siting of the 'barriers' would require much detailed consideration.

Part Four: A central metropolitan block

290. At *Newbury* we examined the problems of a small town, giving some consideration to the impact of traffic on the central shopping area. At *Leeds* we were concerned mainly with the network for a large town. At *Norwich* we were interested in the impact of traffic on a historic city. We then felt a need to look more closely at the detailed problems of accommodating and circulating vehicles amongst a large group of buildings. It is one thing to devise a network which will deliver vehicles to the *parts* of the town where they wish to go, but it is another and crucial matter to effect the final distribution to the buildings. We were interested to discover whether there were problems concerned with the actual arrangement and design of buildings which might put a limit to the amount of traffic that could be accommodated. We also wanted to learn what advantages would accrue from *complete* redevelopment of an area in an improved form, and, at the other extreme, what the effects would be of permitting the haphazard piecemeal rebuilding of individual sites which is now going on in most towns. We also hoped that by close study of one large block of development we might, by considering the effects of a succession of similar blocks put together in all directions, achieve a short cut to understanding the traffic problems of a very large city.

The study area

291. It was this last consideration that led us to choose a study area in Central London. We chose, in fact, the area in the south-west quadrant of the intersection of Euston Road and Tottenham Court Road, this being a suitable mixed-use area, parts of which need redevelopment, but where no controversy was raging in which we might be thought to be involved. We did not rigidly define the southern and western sides of our study area because we wanted to see where considerations of environmental areas would lead us, but we had Great Portland Street in mind as the western limit, and Oxford Street to the south so as to bring in the difficult problems presented by that street. We acknowledge the courtesy of the Architect to the London County Council, and his planning Division, in making survey information available to us.

Main activities

292. The study area is 148 acres in extent, and 9,000 people live and 50,000 people work there. It contains part of the great Oxford Street shopping centre. The major part of its industry is concerned with the clothing trade (which has a link with the clothing shops and stores in Oxford Street), to which a considerable amount of storage and showroom

163 The study area from the air. The great difficulty which the present arrangement of streets and buildings presents for traffic circulation is self-evident from this photograph. Densely-developed sites, with virtually no internal space for parking, are served by a complex awkwardly-arranged network of narrow streets with a mass of intersections each of which is an obstruction to movement. The difference between this street pattern and the hexagonal system for local distribution shown in Figure 180 is indicative of the scale of change which the motor vehicle postulates for our cities.

space is attached. There are a number of specialist shops in the area, including the restaurants and food shops of Charlotte Street and Percy Street, and the motor car showrooms and ancillary shops of Warren Street and Great Portland Street. The main local shopping centres are Great Titchfield Street, Goodge Street and Cleveland Street. There are five underground stations on the roads surrounding the area, one at each corner and one midway along the eastern side, and there are bus routes along the surrounding main roads (Figure 165). The employment, and the floor space occupied by the different uses are shown in detail in Table 7.

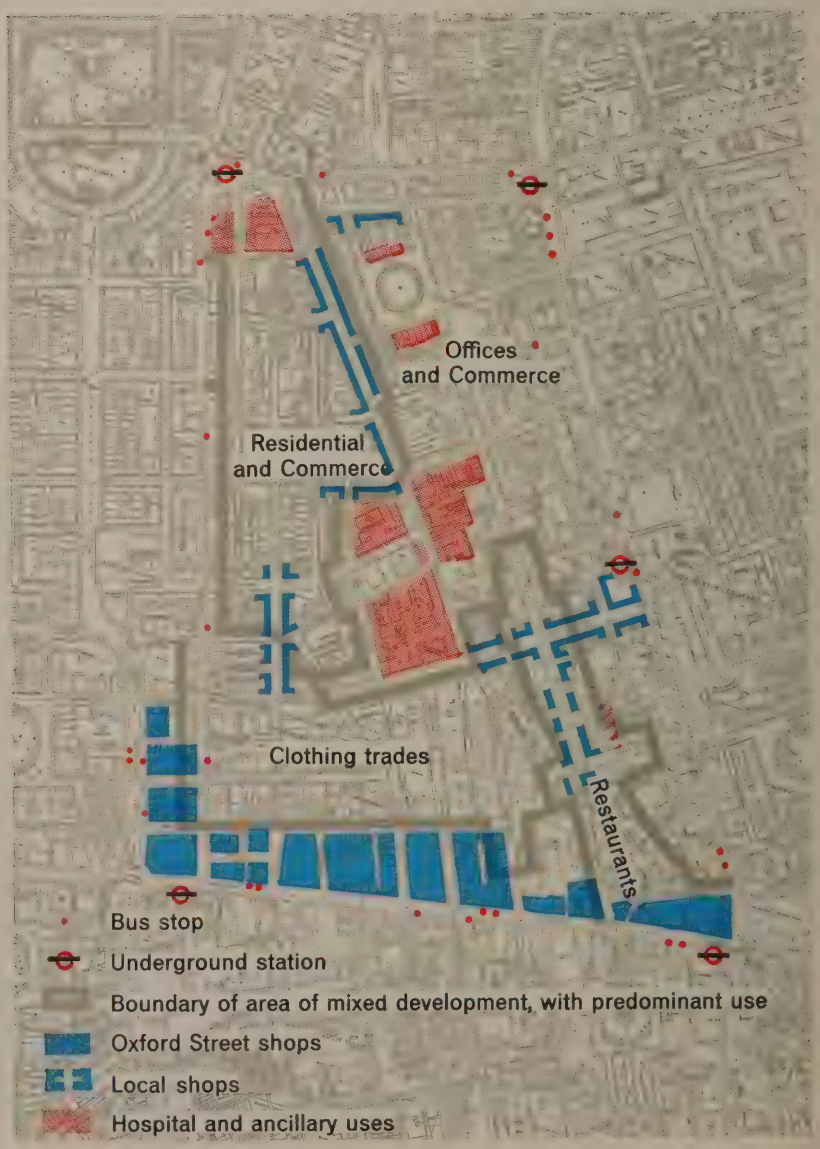
Land use and density

293. Table 8 shows the broad breakdown of the area as between open space, land occupied by buildings and land occupied by roads, the last amounting to 35% of the whole area. A technicality which the reader is invited to understand because it is important to the study is the term *plot ratio* which is the total floor space divided by the net area of the building plots (i.e. excluding roads). This ratio provides a valuable method of indicating the *density* of development and is much used in town planning. The existing overall plot ratio for the study area is 4·4, which is a fairly high figure for this kind of development.

Special characteristics of the area

294. The study area contains Fitzroy Square which is 'listed' as a group of buildings of architectural merit. It also contains the Middlesex Hospital which we assumed would remain in the area in accordance with the London County Council's development plan, and whose main building we thought unlikely to be pulled down. In addition there is a pocket of

164 Charlotte Street near the junction with Percy Street. This part of the street is of potential value for conversion to pedestrian use.



165 The study area showing the predominant uses of land. The Great Titchfield Street local shopping centre is on the west, the Goodge Street centre on the east and the Cleveland Street centre in the north.

18th century development at the southern end of Charlotte Street and in Percy Street which, though not of great merit, might be worth preserving. In general the eastern part of the area suffered severe war damage and is in poor condition, but to the west, the buildings are later and many are very substantial (Figure 167).

Table 7: Existing floor areas and employment

Land Use	Floor Area (acres)	Number of Persons Employed	
Offices	62	13,400	
Residential	91	—	
Shops	65	10,500	
Commerce	63	6,500	
Public Buildings and Education	43	2,600	(Including 2,000 working in hospital)
Industry and Public Utilities	68	17,000	
Unoccupied, etc.	23	—	
Totals	415	50,000	

Table 8: Areas occupied by the main land uses

Land Use	Area (Acres)
Open Space	1
Roads	52
Building Plots	95
Total Area	148 acres

166 Percy Street. A terrace worthy of preservation.

167 Age and condition of buildings within the study area. Buildings shown in red are those 'listed' under S.32 of the Town and Country Planning Act 1962 as of special architectural or historic interest. Fitzroy Square is in the north of the study area. Charlotte Street and Percy Street are in the south-east.

168 Margaret Street. Typical loading problems for the dress trade.

169 Margaret Street. Waste material from the 'rag trade' is dumped on the pavement for collection.

Present traffic difficulties

295. The main difficulties arise from:

(i) Bad layout, with many intersections and narrow streets.

(ii) Multi-purpose use of streets by different types of moving traffic, and for parking and for loading. This condition is particularly bad in the clothing trade area just north of Oxford Street, where service vehicles lining both sides of streets and manoeuvring into position block the way for other vehicles.

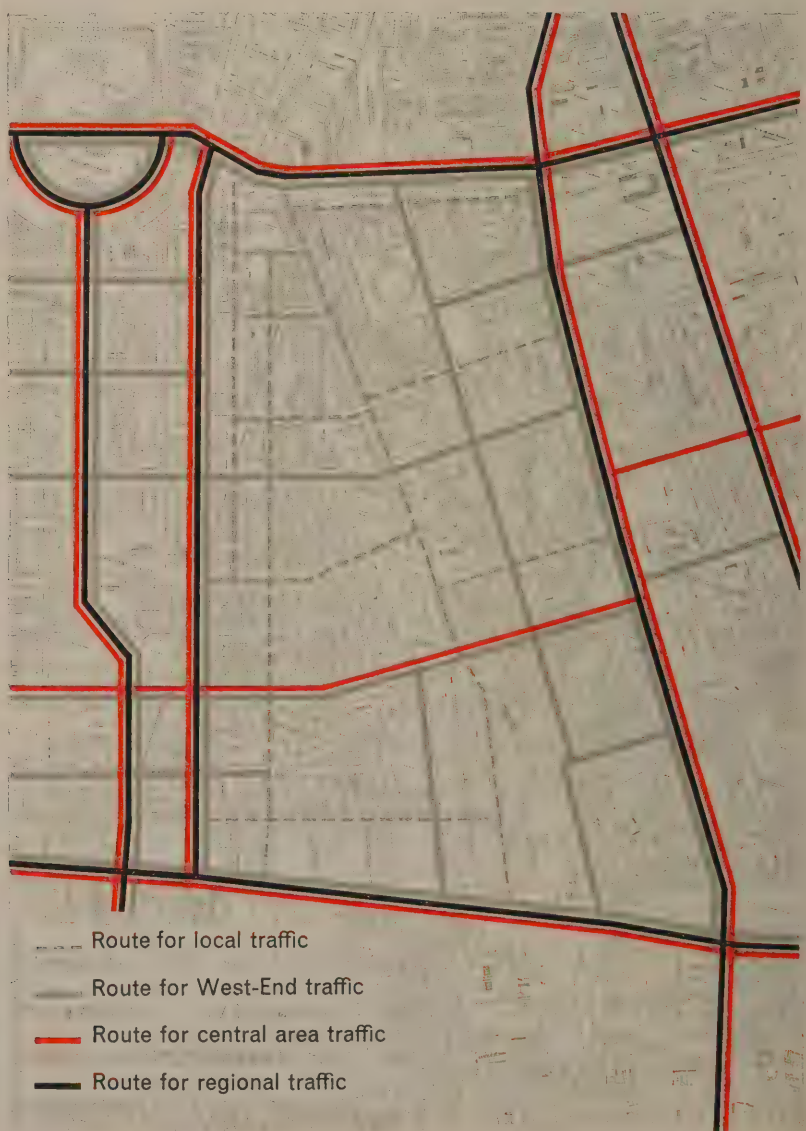
(iii) Inadequate parking facilities and inadequate arrangements for service vehicles. These cause much inconvenience for businesses in the area.

(iv) Congestion by through traffic. We have estimated that out of a total outward peak hour flow of 3,000 vehicles, about one third is through traffic which has no need to be in the area.

In an attempt to improve the position, a one-way system was recently introduced together with parking meters and parking restrictions.

Present parking capacity

296. There are 750 parking meters in the area and about 1,340 authorised off-street parking spaces. There are also some 160 unofficial parking spaces, giving a total of 2,250. If all the official off-street spaces are used by people *working* in the area, and there are on average 1·5 persons per car, then no more than about 4% of the workers can come by car and park within the area. This may be compared with the figure of approximately 7% which now obtains for Central London as a whole. Shoppers, of whom we



170 The various purposes for which roads in or near the study area are used at the present time. Virtually all the roads give direct access to properties in addition to their function for passage.

estimate there are some 115,000 on a busy day (estimated on the basis of 50 shoppers per day per 1,000 sq. ft. of floor space), presumably make what use they can of the 750 parking meters, but as many of these near Oxford Street seem to be taken up by 'essential' vehicles, the proportion of shoppers able to come to this part of the West End by car must be very small indeed. If half the meters were available for shoppers, 1·7% of them would be able to come by car, assuming 1·5 shoppers per car and a turn-over of 3·5.

Conflict between traffic and environment

297. This is most pronounced in the streets where pedestrian activity is greatest (such as Oxford Street), and where heavy traffic flows sever areas or intersect much-used pedestrian routes (such as those to underground stations and bus stops). Most of the accidents to pedestrians occur on the busiest traffic routes surrounding the area or at junctions, as shown in Figure 173.

298. The effect of noise from traffic is particularly adverse in the vicinity of the hospital, and in Oxford Street, where conversation on the pavement is made difficult. And it is Oxford Street again which suffers most from the visual intrusion of the motor vehicle, where continuous streams of vehicles, moving and stationary, prevent the shopper from seeing across the street. Oxford Street really epitomises the conflict between traffic and environment, with its normal two-way peak hour flows of 2,200—3,000 v.p.h., and with its enormous flows of pedestrians. Counts have shown 4,200 pedestrians per hour crossing Oxford Street both ways at Oxford Circus Station, 2,700 per hour crossing at Tottenham Court Road Station,

171 The Middlesex Hospital is bounded by noisy streets on all sides.

172 Oxford Street. Pedestrian flows at junction with Wells Street.

173 The record of accidents in the study area from July-December, 1962 and the relative average daily flow of traffic. (The present one-way traffic system in Tottenham Court Road was introduced in 1961.)

and 3,500 per hour walking along one narrow pavement of Oxford Street at the crossing with Berners Street. Oxford Street is at best a most unpleasant and inconvenient street in which to shop, and at worst it can be lethal.

Other problems

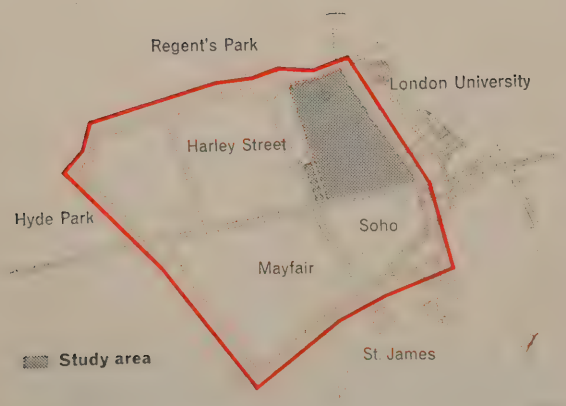
299. These mainly affect the considerable number of people who live in the area. There is very little open space for the 9,000 residents, and no adequate site for a primary school. Many of the living and working conditions are also sub-standard by reason of high densities, obsolete buildings, poor street layout, and the intermixture of incompatible uses.

Full use of cars

300. We first did a quick exercise to check the consequences if every person should seek to go to work by car, every shopper to use a car, and the residents to have all they desired in the way of cars and parking spaces. This is in addition to the essential commercial, business and industrial traffic. We calculated that the peak generation rate for the whole area would be about 40,000 p.c.u. per hour, and that 60,000 parking spaces would be needed. To provide good access for vehicles, the internal road system would need to be on three physical levels, and six distributors of motorway standard with five lanes in each direction would be needed to distribute the peak period traffic to and from the area alone. The design problem for the area itself would not be insuperable, though the whole of it would have to be rebuilt to a very radical plan. But when we considered the consequences for the primary network of a vast continuous spread of areas similar to our study area, for this is what the middle of London really comprises, we realised that the network would become *impossibly* large and complicated. This gave us the very important hint that the amount of traffic to be planned for in our study area was likely to be controlled *not* by what might be needed within the area itself, but by what could be practically contrived in the way of a network to bring traffic to and from the area.

Assumptions regarding the network

301. The foregoing conclusion made us realise that we would not get very far unless we could relate our study area to a network, and form some idea of the amount of traffic the network and its links with the area could deal with. We were in no position to devise a network for the centre of London, yet we felt we knew enough to be quite sure that a primary network would be required if only to deal with essential traffic. The only basis on which we could proceed was to make some assumptions with regard to the centre of London as a whole, and the relationship of our study area to it.



174 Location of the study area in relation to the West End.

Location

302. The centre of London consists of a number of quite clearly defined zones, one of which is the area lying between Euston Road to the north and Piccadilly to the south, Hyde Park to the west and Tottenham Court Road to the east (Figure 174). Our studyarea lies neatly in the north-eastern corner of this area which for the purpose of this report we have called the West End. We therefore decided that it was a reasonable assumption that the boundary roads at the corner, that is Euston Road and Tottenham Court Road, should be regarded as parts of a larger rectangular (as opposed to hexagonal or other pattern) grid serving the central area of London. We also assumed that this primary grid would be required to deal only with traffic generated by the centre of London, and would itself lie within

a 'regional grid' which would deal with through traffic in relation to the central area of London. Although it did not require much consideration to realise that this primary grid would need to comprise roads of motorway standard, *we wish to make it quite clear that this was an assumption for an academic study*. We have not regarded it as part of the exercise to pursue the implications of converting Euston and Tottenham Court Roads to motorways. The implications would be very far reaching, but even if prolonged study of the centre of London resulted in a different network we do not think the results of our study would be invalidated. If preferred, our study could be described in a more abstract way as a 'study of an area bounded on two adjoining sides by primary distributors'.

Capacity

303. Such a primary network system will have a fixed maximum capacity for traffic depending upon its design and dimensions. The number of vehicles entering or leaving one of the areas enclosed by the grid should not exceed the capacity of the network and the roads connecting it to the area. If, for example, through the provision of too many parking spaces, the area attracts or generates more traffic at the peak period than the network can carry, then congestion will result and there will be an enforced lengthening of the peak period.

The 'module' of the network

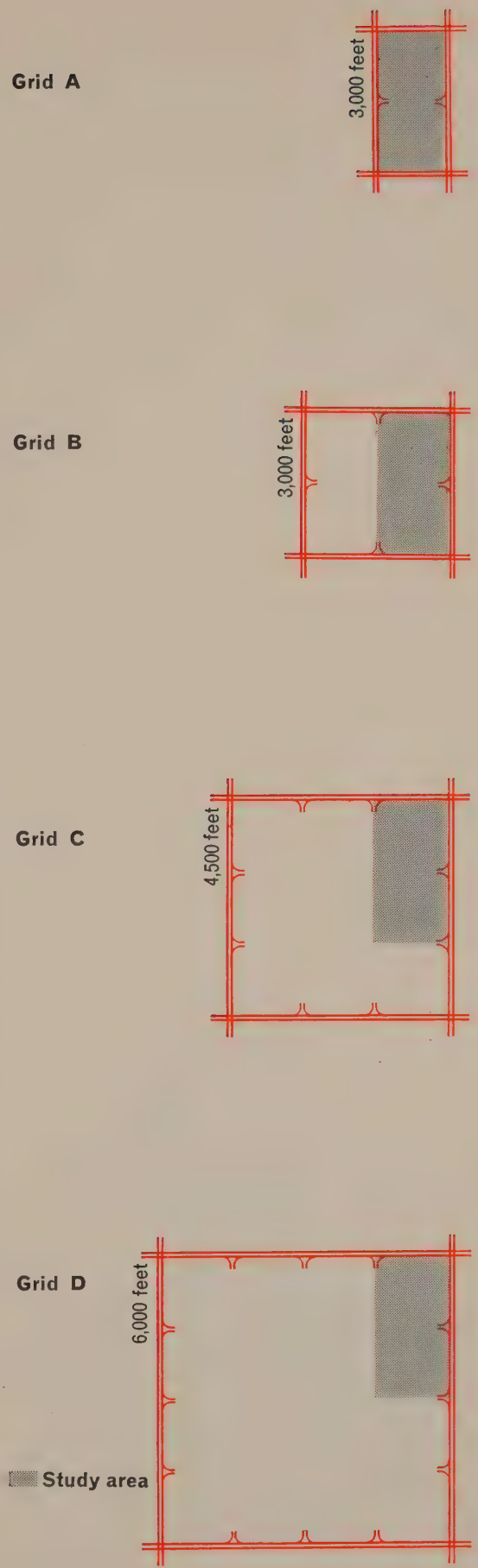
304. In theory, the *smaller* the module or basic dimension of the grid (when it is square or nearly so) the *greater* is the capacity of the grid to distribute or accept vehicles to or from the areas. This is simply because, with a small grid, there is a greater length of primary road for each acre of area that is served. But, for two main reasons, there is a limit to the smallness of the grid. In the first place the amount of traffic that can be transferred between area and grid is governed by the number and capacity of the interchange ramps, and there are certain minimum distances apart that these can be placed for reasons of flow and safety. The second reason is concerned with the fact that an area also generates local trips, and the smaller the grid the more these local journeys tend to be thrown onto the grid, until there comes a point when the additional load outweighs the gain in capacity.

Alternative arrangements of the grid

305. We examined four possible rectangular arrangements for the grid (Figure 175) based on an absolute minimum distance between intersections of 1,500 ft. and maximum possible flows at the interchange ramps of 3,000 p.c.u. per hour (i.e. two-lane ramps running to capacity into additional lanes on the motorway). The smallest of these arrangements enclosed the study area tightly. What we wanted to discover was which of these layouts would permit the greatest amount of traffic to be generated by the area within the grid without overloading the system, with some idea of the actual quantity, so that we could proceed with the design of internal roads and parking spaces for the study area.

306. Assuming the evening peak hour to be the more concentrated of the two, it was a simple matter to calculate for each arrangement of the grid the rate at which departing traffic could leave the area having regard to the capacity of the ramps. The figures are given in line 4 of Table 9.

307. We also had to estimate the additional internal generation, within the areas enclosed by the grid, of traffic which would not use the grid. This we were able to do with the help of information available regarding the proportions of London journeys in various categories of length (e.g. about one third of all car trips are less than a mile, slightly less than one fifth are between one and two miles, about one tenth are between two and three miles, and so on in diminishing proportions). These figures are shown in line 5 of Table 9. Line 6 of the Table shows the 'total permissible generation' for each grid area—if generation exceeds this figure, then congestion at the ramps will occur.



175 Alternative arrangements of the primary grid.

Table 9: Grid capacities and maximum permissible traffic generation for the four arrangements shown in Figure 175

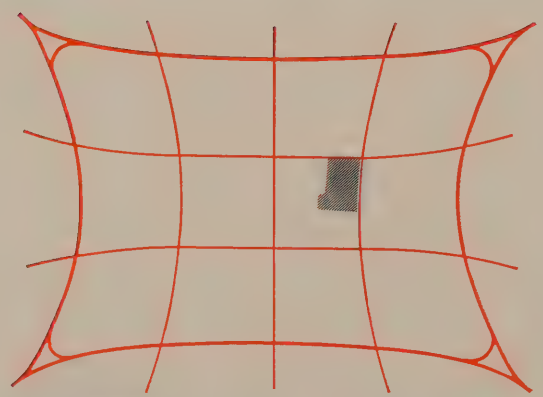
		A	B	C	D
1	Grid dimensions (feet)	3000 × 2150	3000 × 3000	4500 × 4500	6000 × 6000
2	Area enclosed (acres)	148	208	467	832
3	No. of ramps	2	4	8	12
4	Possible traffic exodus rate p.c.u./hr.	6,000	12,000	24,000	36,000
5	Additional internal generation p.c.u./hr.	1,200	4,700	14,000	24,000
6	Total permissible generation for the grid area p.c.u./hr.	7,200	16,700	38,000	60,000
7	Study area as % of grid area	100	71	32	17
8	Total permissible generation for study area p.c.u./hr.	7,200	11,850	12,200	10,200

308. As the smallest of the four grids is identical with the study area, the figure in line 6 is therefore the actual total permissible generation (line 8) for the study area. In the case of the other three grids the study area occupies only a part of the whole area enclosed, so the total permissible generation for the study area is estimated in proportion to the amount of the grid area occupied by the study area.

309. Table 9 shows that the 4,500 ft. square grid would permit the highest level of generation per hour. Below this size a fall occurs for the reasons stated in paragraph 304, and successive increases in size also show a decrease of generation. In the studies that follow, the designs rest on the assumption that in each case the permissible level of generation is taken up to its fullest extent. Its allocation between essential and optional traffic is explained in a later paragraph.

Accumulation of traffic from a series of areas

310. If a primary grid on the lines discussed above were to be established in the centre of London, the volume of traffic passing along any section of the grid would be the cumulative flow generated from all the areas enclosed and passing along that section. We have not attempted to investigate fully the volume of traffic that would build up on all sections of the network grid, but we have satisfied ourselves that such a system would be feasible over a limited area such as the 25 square miles of Central London, provided that longer distance through traffic were accommodated on *regional distributor* roads. The sections of primary distributor bordering our study area would require at least four lanes in each direction.



176 The assumed relationship of the study area to hypothetical primary and regional networks. The grid of both networks is biased towards the area of maximum traffic generation.

Objectives of the studies

311. Before turning to the redevelopment studies we defined the objectives as follows:

(i) To show how the scale of redevelopment and traffic architecture affect the levels of accessibility and environment;

(ii) to examine the way in which the capacity of the network and that of the redeveloped area interrelate;

(iii) to explore major 'design assumptions'—e.g. whether to provide separate levels for pedestrians and vehicles, whether to provide infiltration of some vehicles, or to provide for more vehicles to be parked at greater distances from their destinations; and

(iv) to explain briefly the methods used in the studies.

312. As in the previous studies we had to make many assumptions in order to permit the work to proceed. More detailed examination of the planning problems of the area, and its relation to a wider area, might result in some of these assumptions being questioned, and in particular might well suggest that changes in the land uses and amounts of floor space are needed.

The first study: complete redevelopment

313. In the first scheme we decided to explore how, and to what advantage, the area might be *completely* redeveloped. This was not intended to show any disrespect to Fitzroy Square and other buildings worth preserving, but simply to explore the factual possibilities.

Land use and accommodation

314. We decided, unless serious difficulties were met, that the replacement within the area of all the existing uses should be accepted as a condition of redevelopment, with roughly the same amounts of floor space as now exist. So the first step was to determine the broad disposition of land use in the area. The present uses form themselves into four main groups:

(i) *Family dwellings* with open space, school, and local shops.

(ii) *The Hospital.*

(iii) *The Oxford Street* shopping centre, including some public buildings, offices and single-person dwellings.

(iv) *Industry and Commerce*, including local specialised shops and showrooms, and some public buildings and offices.

315. We saw no reason to alter radically the present location of these groups, but some improvements could be introduced. We decided to place some of the family housing at the north end of the site near the Park, some around new open spaces, with the remainder at nodal points in the industrial and commercial area. The Oxford Street shopping centre would remain in its present position. The area to the north of Oxford Street would be occupied by industrial and commercial buildings. Through this area a group of showrooms and local shops would be arranged so as to form the basis of a comprehensive pedestrian system (Figure 177).

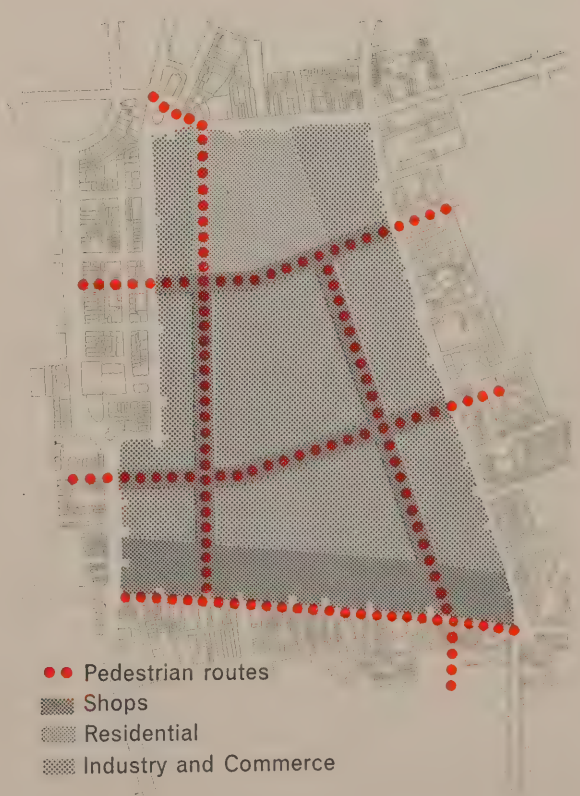
Densities

316. We then had to decide the densities of the re-instated uses. Working to London County Council standards, we assumed an average residential density of 200 persons per net acre for the 7,000 permanent residents (the remaining 2,000 of the total population being in hotels and hospitals), a minimum open space provision of 0·75 acres per 1,000 permanent residents, a plot ratio of 5·0 for Oxford Street shopping and 3·5 for all other non-residential uses. We also assumed that a 2-acre primary school site would be required. On the basis of these standards, 34 acres or 23% of the total site area, would be left for roads, loading and parking. This seemed very little, and gave us a warning that when road, parking and loading requirements were worked out in detail, it would probably be necessary to make more space available by one or both of two methods:

(i) by raising plot ratios but keeping overall floor areas constant—in effect by reducing the amount of land covered by buildings, or

(ii) by creating more space through the introduction of additional physical levels for vehicles or pedestrians.

In these calculations we assumed that half the commercial use would be underground storage which in accordance with convention was excluded



177 The broad allocation of land uses, and the proposed pedestrian routes.

Table 10: Estimation of essential and optional traffic

All traffic	
Maximum permissible peak hour generation	12,200 p.c.u. per hour (1)
Essential traffic	
Total future daily generation of essential journeys (round trips taken at $2\frac{2}{3}$ times the present level)	36,000
Peak hour generation of essential journeys (assuming 8% of total journeys occur at peak hour)	2,900
Peak hour generation expressed in p.c.u. (assuming one-third of vehicles are medium and heavy)	3,800 p.c u. (2)
Parking spaces required for cars used for essential purposes (assuming 12,000 car trips daily with turnover of 6)	2,000 spaces
Loading bays and parking space for other commercial vehicles (assuming 24,000 trips daily and turnover of 6·5)	3,700 spaces
Public service vehicles	
Equivalent peak hour load created by P.S.V.s (assuming, pro tem, that 150 buses leave the area during the peak hour)	450 p.c.u. per hour (3)
Optional traffic	
Balance of peak hour generation available for all optional traffic, i.e. 1 — (2 + 3)	7,950 p.c u. per hour (4)
Allowance for trips other than those connected with work or shopping	750 p.c.u. per hour (5)
Shopping traffic	
Estimated total number of daily trips by all forms of travel	115,000
Number of trips made by car at 20% of total	23,000
Number of cars used at occupancy rate of 1·5 persons/car	15,500
Number of parking spaces required at turnover of 3·5	4,440
Equivalent peak hour load (assuming 14% of outward trips at peak hours)	2,200 p.c.u. per hour (6)
Work journey traffic	
Balance of optional peak hour generation available for work journeys, i.e. 4 — (5 + 6)	5,000 p.c.u. per hour
Number of cars used for work journeys (assuming two thirds of workers leave during peak hour)	7,500
Equivalent number of workers travelling by car (assuming occupancy rate of 1·3 persons/car)	10,000
Total number of workers in area	50,000
Percentage of workers travelling by car	20%

from the plot ratio figures. The plot ratio for the scheme, excluding residential uses, is 3·7. This is lower than the existing figure because the total area of the plots is augmented by the inclusion of some road and parking areas which share ground space with the buildings, but at different levels.

Choice of the network grid

317. Being anxious to explore the implications of the highest possible level of traffic generation within the area, consistent with the capacity of the road system both inside and outside the area, we selected a 4,500 ft. square grid having eight points of connection with the area enclosed (Figure 175, grid C). Three of these enter directly into the study area, assuming that two sides of the grid are formed by Euston Road and Tottenham Court Road. As shown in Table 9 this arrangement permits a maximum peak hour generation by the study area equivalent to 12,200 p.c.u. per hour.

Allocation of the permissible generation

318. The problem we had to deal with was to allocate the permissible generation of the study area between a number of demands. The 'essential' traffic we assumed had to be provided for in full. Because we knew that the balance was not nearly big enough to allow all the trips to be made by car, we first estimated the amount of essential traffic, and by deduction obtained a balance which had to serve for car commuters, car shoppers, miscellaneous car trips, *and also for buses*. The only way we could proceed was by a process of trial and error. In the calculations summarised below we have, after estimating the needs of essential traffic, adopted an arbitrary allocation for buses. We then worked out the balance available for all optional traffic, and after making another arbitrary allocation for shopping-by-car traffic and other private traffic, we arrived at the final balance available for journey to work by car. This last figure we expressed in terms of the percentage of all persons working in the area for whom space could be found to enable them to commute by car. The figure is 20%.

319. We then checked back on our arbitrary assumptions for bus traffic. Having deduced how many could travel by car, and also how many would walk, we knew the remainder would require public transport. Some would travel by tube and others by express bus from 'picking-up' points connected directly to the network, so that only a proportion would actually board local buses. The proportion travelling by tube was assumed to be much the same as at present, i.e. about 60%, and of the remainder, about half were assumed to find local buses. In this manner, it was deduced that about 190 buses would have to leave the area during the peak hour, a figure which was sufficiently close to our original assumption not to invalidate the remaining calculations.

320. The calculations made to determine the number of parking spaces, loading bays, etc., and the proportion and amount of optional traffic are summarised in Table 10.

321. The parking requirements and amount of traffic generated are summarised in Table 11. We realise the tenuous nature of some of the assumptions on which these allocations are based, but we think they are broadly of the order that would have to be made in practice. The assumption that 20% of the shoppers would travel by car was made because it led to the same percentage applying to persons driving to work by car. In other words the capacity available was allocated equally, but any other proportions could have been chosen.

322. We estimate that, if there were no restraints whatsoever on the use of cars for journey to work, about 70% of all people working in the area would choose this means of travel. The remainder would be people who for one reason or another use other means of travel. So in fact the allocation we have made would meet almost 30% of the actual demand. By similar reasoning the allocation for shoppers might enable as much as 60% of the actual demand for car shopping to be met, allowing for the fact that many shoppers would already be in the area for some other purpose.

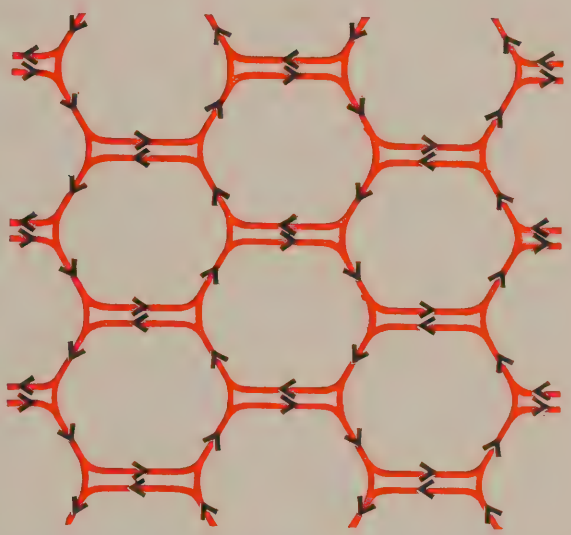
Table 11: Number of parking spaces required and traffic generated (complete redevelopment)

Activity	Type of Vehicle	Number of spaces Required	Type of Space	Traffic Generated (p.c.u.)	
				Evening Peak hour	Total Daily
Industrial Business and Commercial	Cars Vans & Lorries	2,000 3,700	Short term parking Loading or waiting	3,800	48,000
Shops	Cars	4,400	Short term parking	2,200	15,500
Work places	Cars	7,500	Long term parking	5,000	7,500
Residences	Cars	5,000*	Private parking & garaging	negligible	12,000
Other	Cars	1,000	Short/medium term parking	750	8,000
Public transport	Buses	20	Stopping places	450	4,000
			Total traffic generation:	12,200	95,000

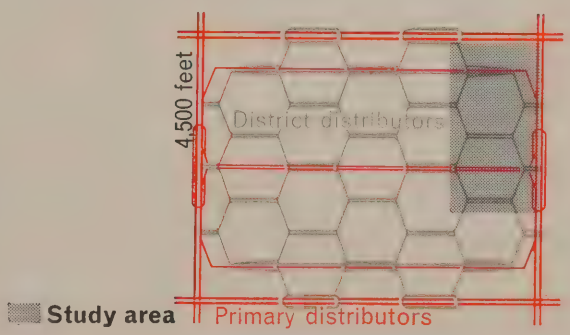
* It was assumed that 3,000 dwellings would be needed for the 7,000 permanent residents, of which 1,000 were allocated 2 car spaces each and 2,000 were allocated 1·5 car spaces each.

Arrangement of internal distributors

323. As we were considering the *complete* redevelopment of the site we had a free hand, and therefore adopted a one-way hexagonal system which provides a freely-flowing system with simple uncontrolled three-way intersections (Figure 178). To improve its efficiency and to spread the points of entry, supplementary cross-links off the primary distributor have been introduced (Figure 179).



178 A one-way hexagonal system of distributors with single-level uncontrolled junctions.



179 Theoretical arrangement of internal distributors within the primary grid.

Levels

324. The density of development and the area needed for roads, parking and servicing were such that we could be reasonably sure that a multi-level plan would be required in order to gain the necessary space. We therefore gave some general consideration to this question to see what principles were involved.

325. First we could see that there were advantages in keeping the primary motorway distributors at the lowest physical level of all the roads in the distributor hierarchy, and preferably *below ground level* in open cuttings. Experience abroad points to this being the most desirable on the grounds of reduction of severance, noise, and visual intrusion. In addition, if the primaries are generally at a lower level than the intersecting roads, then the design of interchanges is much facilitated, the primary does not have a switchback profile, and the slopes on the 'on' and 'off' ramps assist acceleration and deceleration.

326. With regard to the relationship between the local distributors and the buildings themselves, the alternatives broadly are to keep pedestrians 'down' and vehicles 'up', or vice versa. The first has the advantage of freeing the whole ground area for pedestrian use, giving in effect an urban park with direct pedestrian access into the ground floors of buildings. Also, if vehicles are taken into buildings at some intermediate level in their height, it can be a useful arrangement where uses are divided vertically, e.g. traffic can serve shops *below* and offices *above*. Moreover, wonderful urban views can be obtained from high level access roads. There are, however, severe disadvantages in this arrangement which result from the rigid discipline that the high-level roads impose on the buildings, such as the amount of space taken up by access ramps, problems of structural design, and the cost. After considerable study of these problems we felt that it is a better principle in areas of high density to keep traffic at ground level, and to put the pedestrian environment above. This makes for much greater flexibility in the planning of the buildings.

327. Our conclusions on the question of levels, therefore, were to place the primary distributors at about 20 ft. below ground level, and to keep the hexagonal local distributors at ground level (Figure 180).

Alternative forms for the parking space

328. The space required for parking is about double that required for any other single land use, and nearly as extensive as the whole study area itself. We had to decide broadly between concentrating this parking space into multi-storey garages, or spreading it partly in underground car parks beneath the buildings, and partly in the buildings themselves.

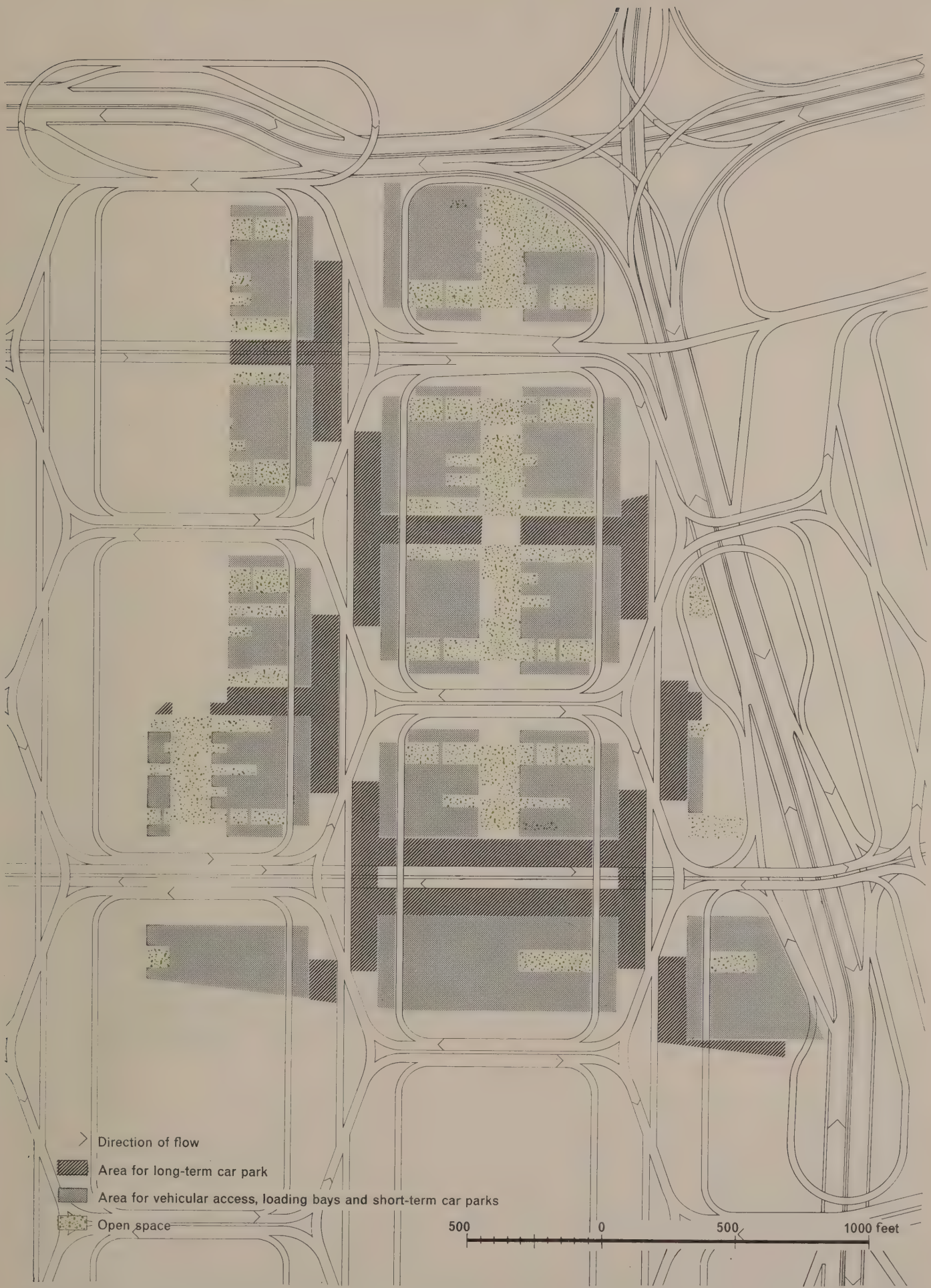
329. Multi-storey garages are big generators of peak period traffic. If situated with direct access to a local distributor there is the risk of overloading; if situated on a primary distributor the garage is likely to be inconvenient and too distant from the buildings. Perhaps because not enough attention has been given to their design, there are few multi-storey garages in existence in this country which are anything more than a blot on the urban landscape—this is an important point in central areas. Multi-storey garages are not altogether suitable for short term parking purposes, yet, in the present case, nearly 50% of the parking is needed for shoppers and essential car users—both requiring short term spaces close to destinations. On the other hand there is no reason why *commuters' cars* should not be concentrated into parking garages at strategic points, nor why (judging by the way people are ready to walk from London main line terminals) they should not be prepared to walk (through pleasant surroundings) distances up to $\frac{1}{2}$ mile.

330. For the present study we decided that the balance of advantage lay in spreading the bulk of the parking in underground space, rather than concentrating it in multi-storey garages. This conclusion is probably valid only in the context of (i) a high density, high-value central area, and (ii) an area where large-scale comprehensive redevelopment is being undertaken. We recognise the advantages of multi-storey garages for fitting concentrations of parking spaces into existing town centres, where comprehensive development is not being undertaken.

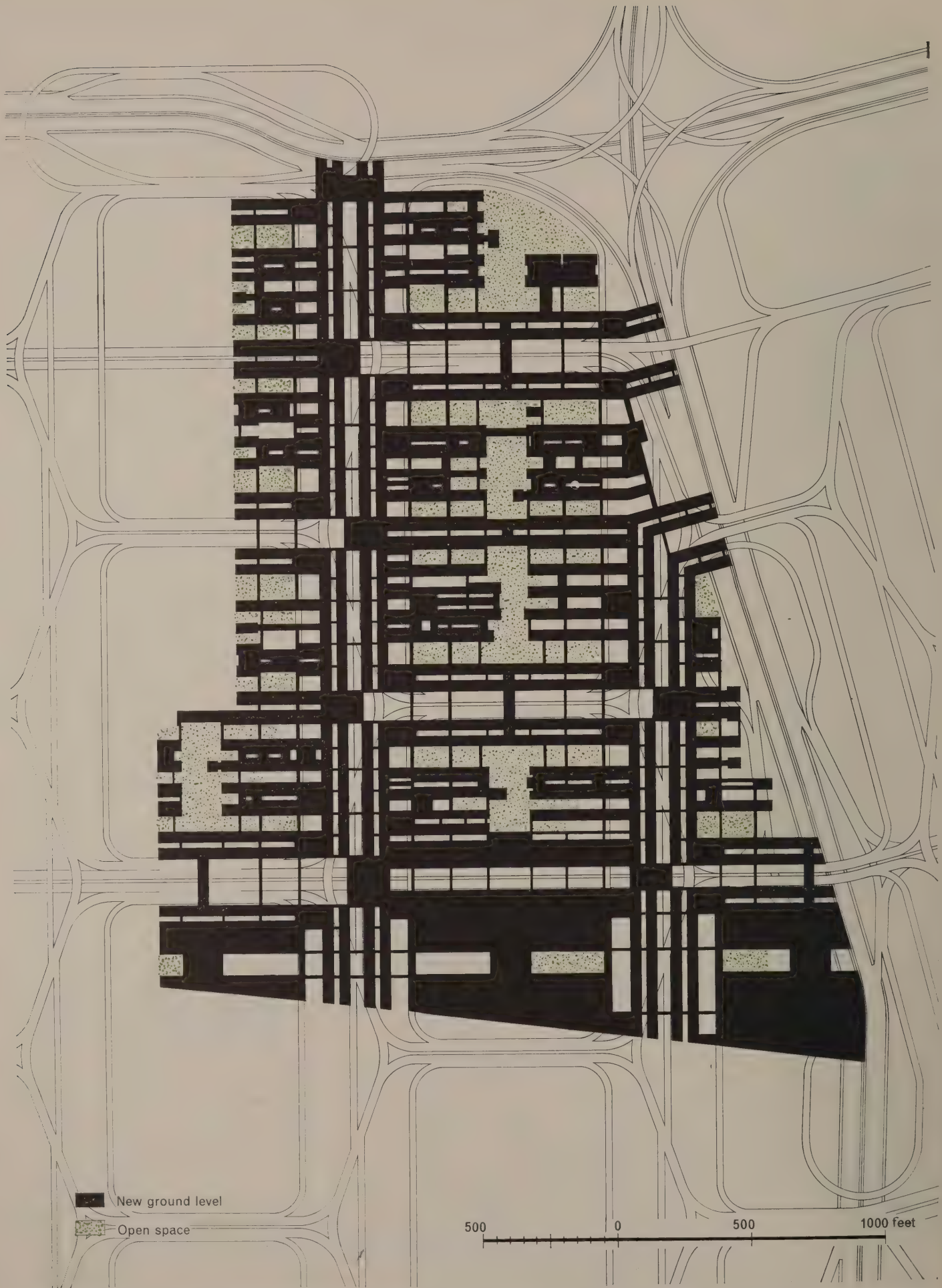
The design for complete redevelopment

331. The decision to place the busy district and local distributors at ground level, the considerable areas required for parking, garaging and servicing, the decision to 'spread' the parking rather than to concentrate it, the need to avoid excessive excavation of the site for parking purposes, and the desire to create a good environment for pedestrians, all led inevitably to a design with a pedestrian circulation system set above the traffic. This would in effect become the 'new ground' level for city life, a platform from which the buildings would rise. The car parking and the service areas would be underneath the buildings—that is, with access at the original ground level. In the design as it emerged, however, there was nothing resembling a solid deck or platform. The 'new ground' proved to have a complicated lacework pattern like a sheet of metal out of which stampings had been punched, a criss-cross of building sites and pedestrian ways with frequent openings to let light, air and views to the lower level, and with the pedestrian system descending at many points to open spaces on the original ground (Figure 181).

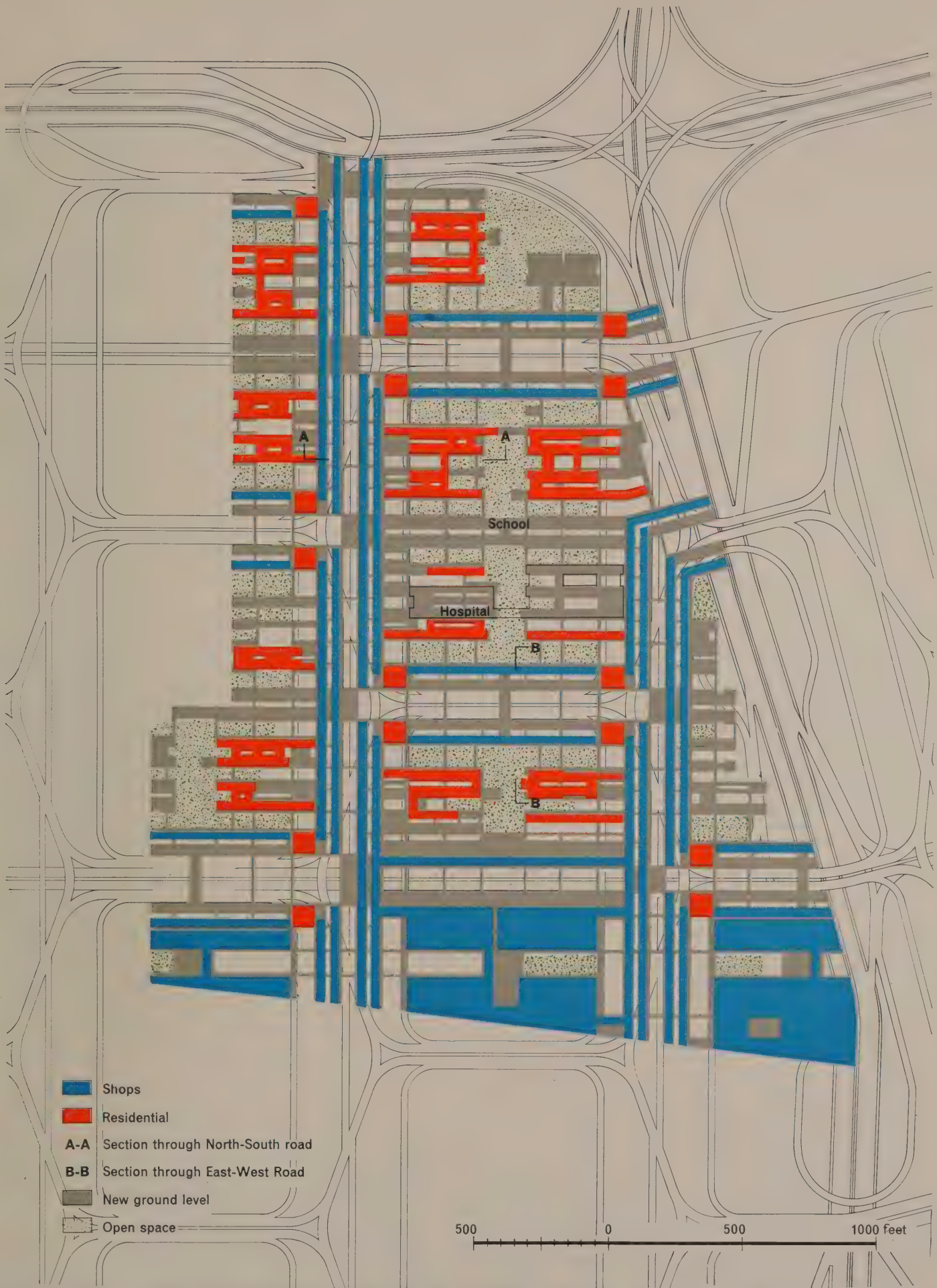
332. At first glance there appears to be very little resemblance between Figure 181 ('new ground' level) and Figure 180 (real ground level, showing distributors and access roads). The whole pattern and grain of the two plans seems entirely different. This illustrates the flexibility for design which results from the basic decision to create a pedestrian environment *above* the main traffic level. But, of course, there is a close relationship between the two levels. At the southern end of the site there are extensive platforms on which would be replaced the shops and stores from the north side of Oxford Street. Parking spaces would be provided underneath the stores, and also at several other levels. Access into the various parking areas from the primary distributor via the spur road would be very direct. Running northwards from the main shopping centre, and directly above the zig-zag line of the secondary distributor formed out of the two western sides of the hexagon, is a corridor or core of local shops. This corridor



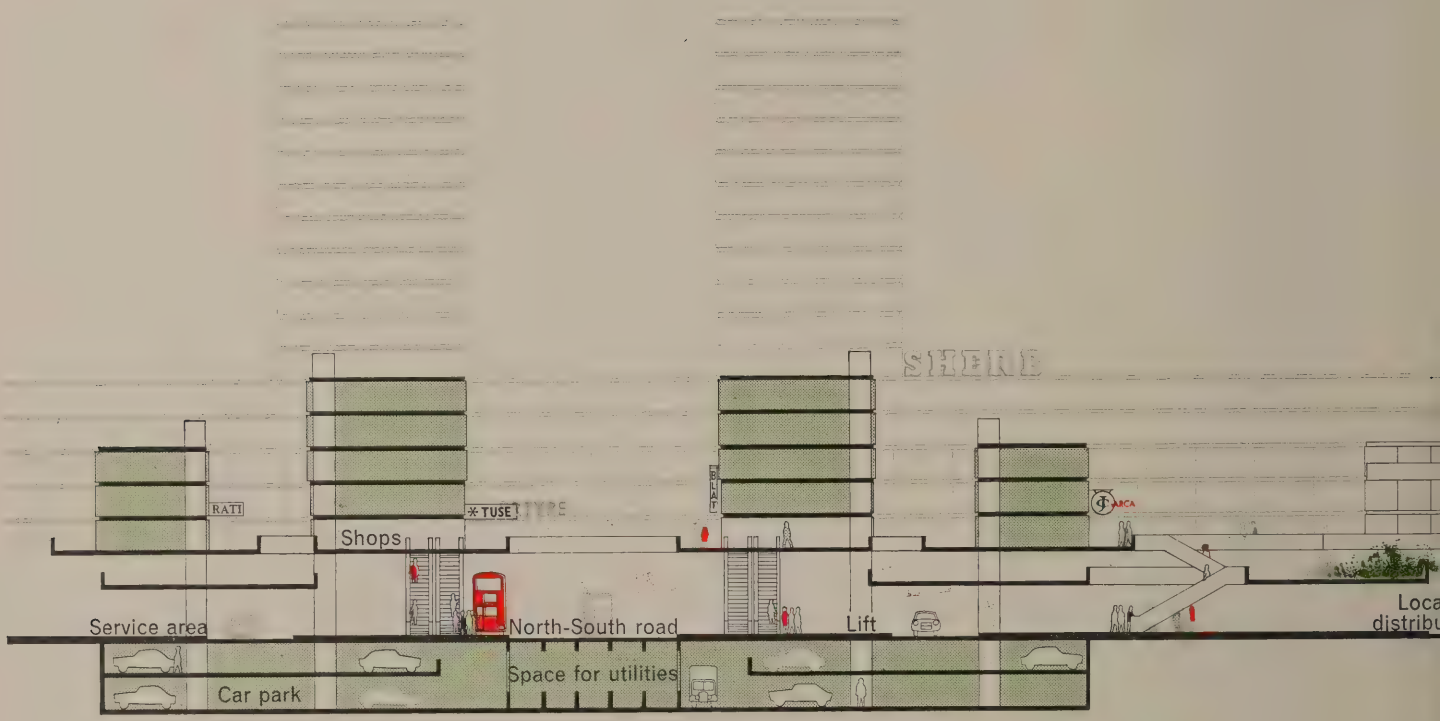
180 The design for complete redevelopment—plan at ground level showing the full development of the hexagonal distribution system, and the parking and service areas.



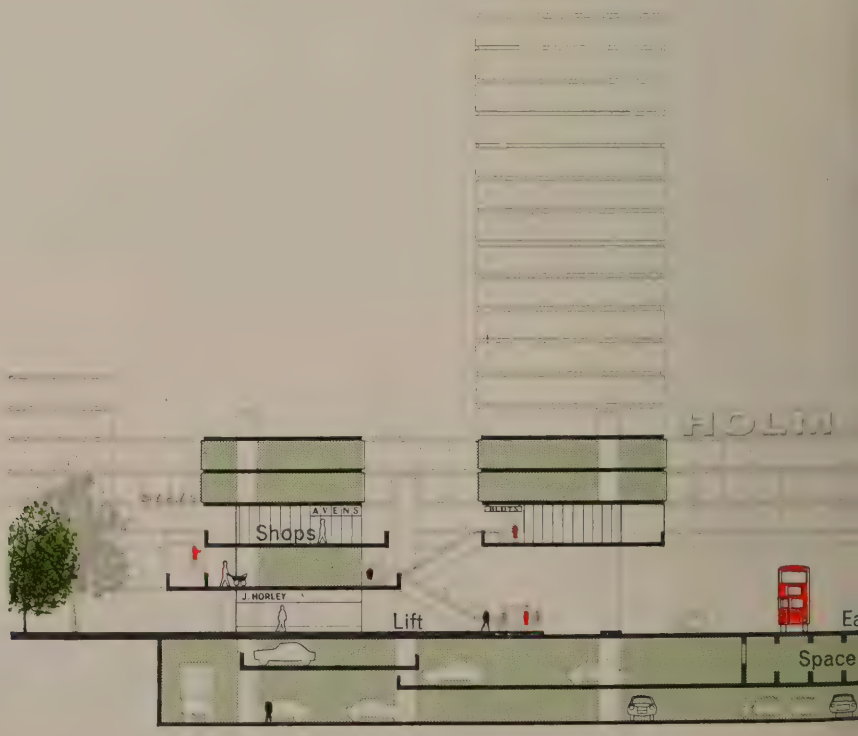
181 The design for complete redevelopment—plan at 'new ground' level showing in black the new perforated deck on which the new buildings would arise.



182 The design for complete redevelopment—plan showing the broad disposition of uses at deck level. Sections A-A and B-B refer to Figures 183 and 184. Areas on the new ground level which are not indicated for shops or residential use are for office, commercial and industrial purposes.



183 Design for complete redevelopment. This sectional view (for the location of the section see AA on Figure 182) shows the north-south zig-zag road on the left-hand side, with local shops above it at the new ground level. Pedestrian ramps and walkways link down to the open space on the right-hand side of the section.

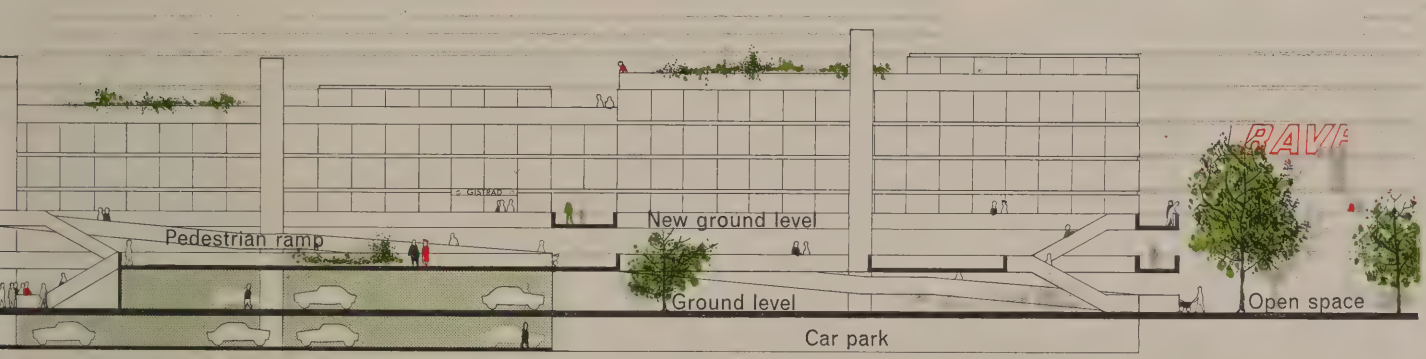


184 The design for complete redevelopment. Sectional view (BB on Figure 182) showing the east-west two-way road with escalators down to the bus lay-bys, and the ground level open space with housing blocks in elevation behind.

consists of two galleries 50 feet apart, centred on the zig-zag road, with frequent pedestrian bridges linking the two sides, on which small shops and kiosks are grouped. There is another similar corridor above the zig-zag distributor on the eastern side of the site, and further shopping corridors above the two east-west links of the hexagons. But these links would be noisy two-way roads and therefore the corridors have been made wider with the shops facing away from the road. The groups of bachelor dwellings are sited at nodal points where the two routes meet (Figure 185). Figure 183 shows a section through the north-south hexagon road and Figure 184 a section through the east-west road.

333. The hospital is re-established approximately in its present position, with open space around it. The main groups of industrial and commercial buildings and show-rooms occupy sites running at right angles to the shopping corridors. In the centre of the area there would be some ground-level open space—a very urban kind of space, but possibly with forest-sized trees. Some of the family dwellings would be grouped around it. Given a continuation of this kind of development to adjoining areas, then footways and buildings could flow right over the primary distributors. (Figure 182 shows the location of shops, dwellings and open space.)

334. The outline we have given of the traffic calculations shows quite clearly that the area, even when redeveloped completely, would still have to depend very largely upon public transport to bring in the working population and the shoppers. The hexagonal distributors would provide

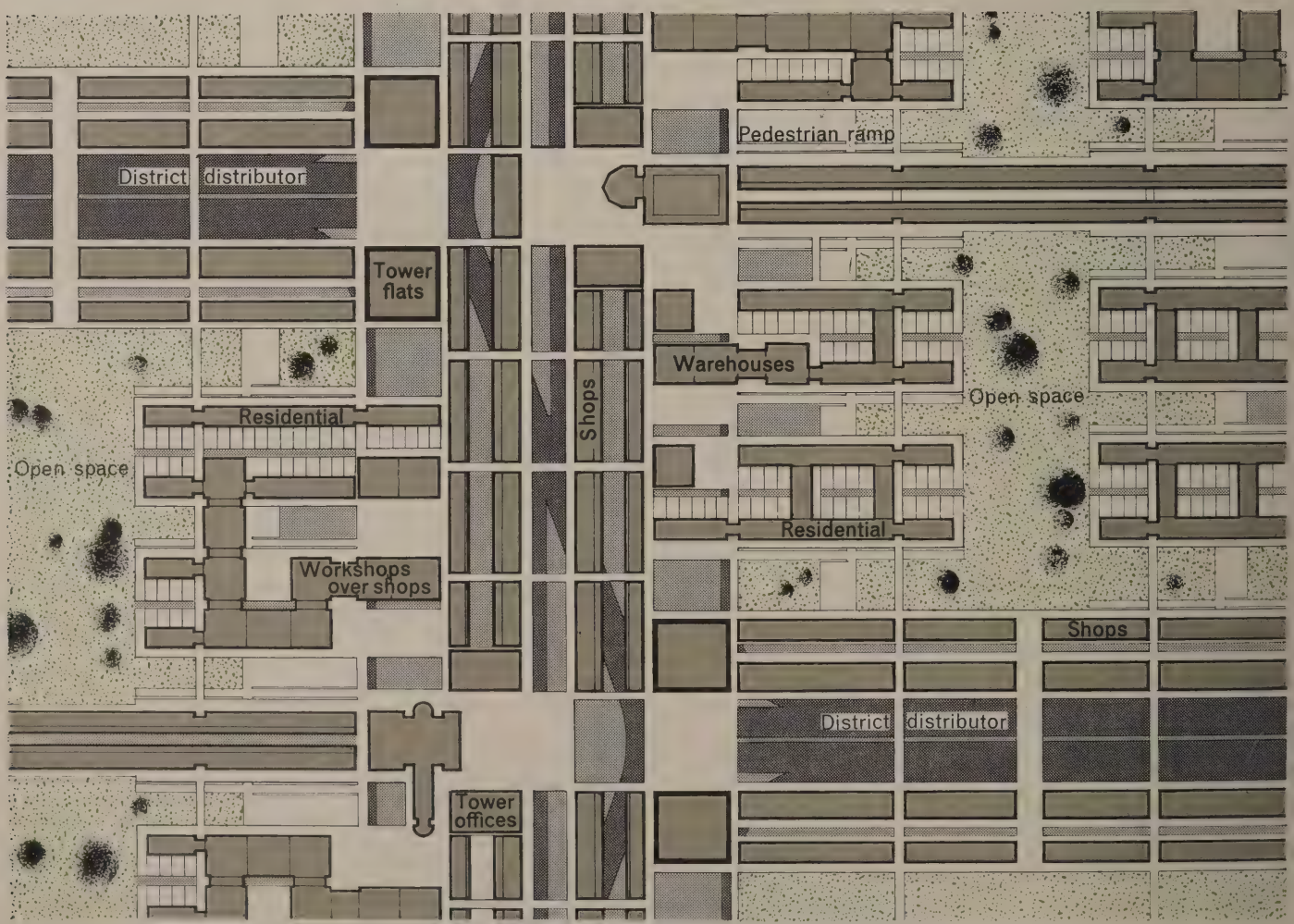


convenient local bus routes with stopping places underneath the buildings. Access could be arranged to longer-distance or regional bus services on the primary distributors. The five existing underground stations would be directly linked with the pedestrian level.

Conclusion

335. We did not pursue the study any further than this. We had satisfied ourselves that even given complete and total redevelopment of a central high-density site, there would be a strict limit to the amount of traffic it could accommodate, dictated not so much by its own capacity as by the feasibility of providing a network to serve it and all the adjoining areas. Even so it was evident that to accommodate the maximum flows from the network (which satisfied all essential needs) would require a highly intricate multi-level design. To bring such a design into being would need an almost revolutionary approach to questions of land ownership and development procedure, but we are satisfied that there is nothing fantastic about the design itself. It illustrates vividly the point we have previously made that the awkward truth is that the motor vehicle is really demanding a radically new urban form. We think the design we have described gives an indication of the kind of form required, and shows that it would be possible to create a compact, varied, interesting, vital, intensely urban environment, yet with many of the advantages of motor traffic close at hand. But the design process requires a new outlook, a new synthesis of professional skills, for it is neither designing roads nor designing buildings, but designing the two together as a unified process. This is what we mean by traffic architecture.

185 Diagrammatic layout of part of the pedestrian deck above the hexagonal road system. The *white* areas represent the new pedestrian level. Corridors of shops are located above the north-south zig-zag distributor, and to the flanks of the east-west distributors. Housing is grouped around the open space. This diagram is only intended to typify the kind of layout that could be achieved.



186 An impression of the scheme for complete redevelopment, looking along one of the district distributors. Ground-level open space can be seen to the left. The drawing shows that in a multi-level reconstruction, the 'driver's eye view', far from being gloomy and subterranean, can be lively and interesting with plenty of opportunity for the driver to identify his whereabouts.


P&O

The second study: partial redevelopment

336. We next decided to see what the consequences would be of a stipulation that the buildings of architectural and historic interest should be preserved, and that the redevelopment should be capable of being carried out by different developers in stages as a phased operation. We wanted to make this a more realistic exercise, with redevelopment of a kind that might be possible given full co-operation from owners and developers. We decided, however, to go back ten years in time for our starting date, in order to avoid the embarrassment of the various new buildings in the area. These, all examples of piecemeal redevelopment, do in truth, effectively ruin the real chances of comprehensive rebuilding in the study area, and hence of dealing adequately with traffic (Figure 188).

The network grid

337. In this example, seeing that the emphasis to some extent lay on preservation, we decided to adopt the larger network grid which would surround rather than divide the West End. This, of course, reduced the capacity of the network and hence the maximum permissible traffic generation by the study area to 10,200 p.c.u./hour (Figure 175 and Table 9, Grid D).

Land use and accommodation

338. We decided to work broadly to the same density and other standards as in the first scheme, and to seek again to replace within the area all the

187 Buildings proposed for retention in the partial redevelopment study.

uses and accommodation at present existing there. The acceptable level of traffic generation was lower than in the first scheme, but we have assumed that there would be no difference in the essential traffic generation at the peak hour (3,800 p.c.u. per hour), and that this would again be given priority.

Allocation of permissible generation

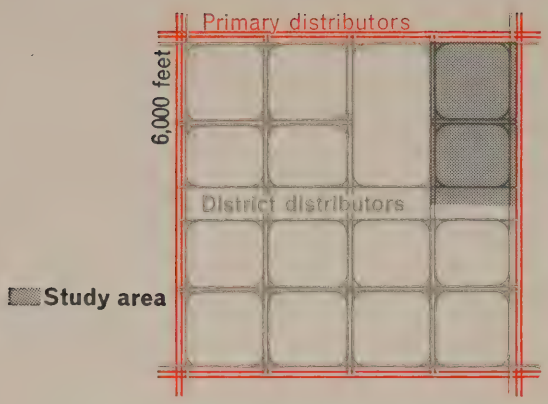
339. The maximum permissible traffic generation for the study area, and its allocation for the parking of essential or optional vehicles, is shown in Table 12. The assumptions and methods described in para. 320 have again been used.

340. In this Table we have assumed that some 15% of shoppers travel by car. Allowing for the needs of essential vehicles, the system would enable 15% of the work people to come in by car also. This means in effect that just over 20% of the potential demand for car use for the work journey could be accommodated.

General form of redevelopment

341. In this scheme it would be necessary once again to resort to a 'new ground' level in order to separate pedestrians and vehicles in the areas to be redeveloped, and to fit in all the activities and the extensive parking requirements. We assumed a distribution of main uses roughly as in the first scheme, though with a more homogeneous housing area in the north. The need to preserve Fitzroy Square, coupled with the problems posed by the intersection of the primary distributors and the retention of the hospital, all led us to place some of the dwellings and open space at the southern end of the site.

188 Sites which were available after the war and which could have been used to enable a start to be made on comprehensive redevelopment. Most have now been redeveloped piecemeal fashion, and the chances for radical change have largely gone.



189 Scheme for partial redevelopment. Theoretical arrangement of internal distributors within the primary grid.

Table 12: Number of parking spaces required and traffic generated (partial redevelopment)

Activity	Type of Vehicle	Number of Spaces Required	Type of Space	Traffic Generated (p.c.u.)	
				Evening Peak hr.	Total Daily
Industrial Business and Commercial	Cars Vans & Lorries	2,000 3,700	Short term parking Loading or waiting	3,800	48,000
Shops	Cars	3,000	Short term parking	1,500	10,700
Workplaces	Cars	5,400	Long term parking	3,600	5,400
Residences	Cars	5,000	Private parking & garaging	negligible	12,000
General purposes	Cars	900	Short and medium term parking	700	7,000
Public Transport	Buses	20	Stopping places	600	4,500
			Total traffic generation:	10,200	87,600

Arrangement of internal distributors

342. We could not use a hexagonal system in this case because it was necessary to plan for redevelopment in stages, and therefore the existing arrangement of streets and buildings had to be taken into account. We accordingly devised a rectangular pattern, with signal-controlled intersections. A disadvantage of this is that it necessitates district distributors to the north and the east which are close to and parallel with the primary distributors. We decided the best way to deal with these was to push them right up to the primaries so that they become almost part of it. This concentrates noise and reduces internal severance, though it makes the primary distributors even more formidably wide (Figure 191). As in the previous scheme we decided the primary distributors were best placed 20 feet below ground level, and the other distributors at ground level.

190 The theoretical arrangement of primary and district distributors.

191 In order to reduce noise and severance the primary and district distributors are here combined.

192 The design for partial redevelopment—plan at ground level showing the primary, district and local distribution road system together with the parking and service areas.

Plot ratio

343. We found in this case that the total area taken up by the distributors amounted to some 38 acres. As expected this was more than in the first example, and as a consequence we had to reduce the amount of land devoted to buildings. To maintain a fixed total floor area the plot ratio had to be raised from 3·7 to 3·9.

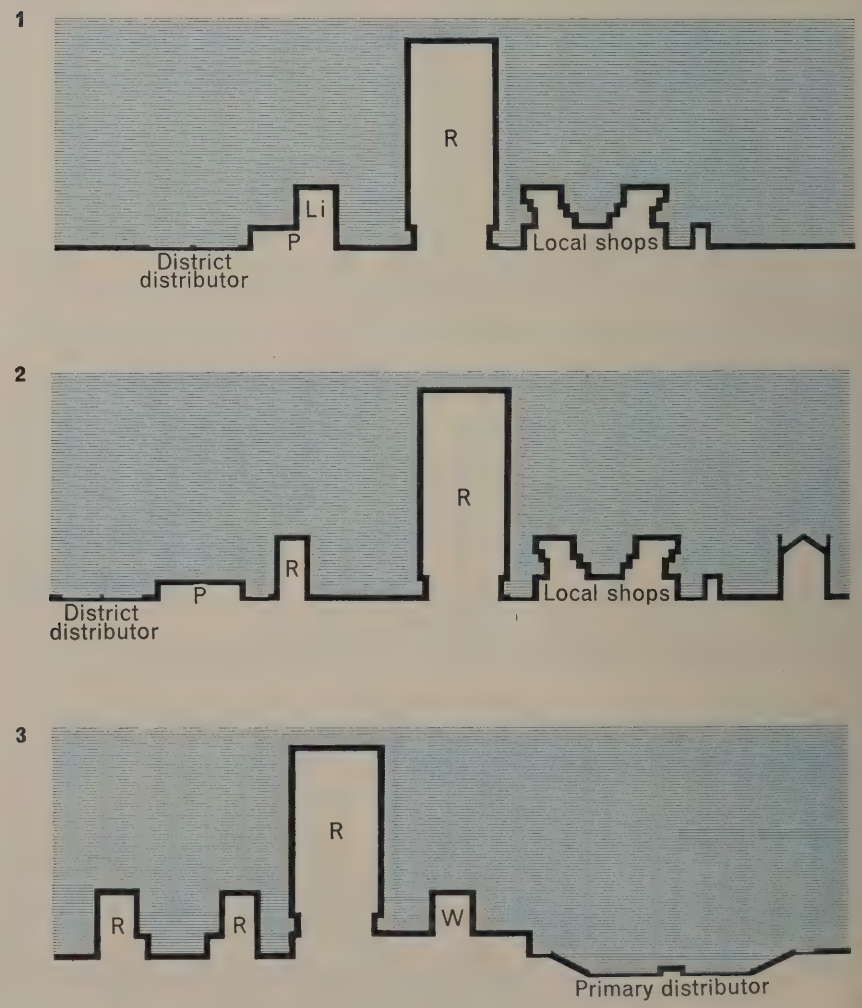
The design for partial redevelopment

344. The broad allocation of land uses and the 'new ground' level are shown in Figures 196 and 197 respectively. As before, we decided that the local shops were best concentrated along a linear elevated pedestrian way, linking the dwellings in the northern part of the area to the Oxford Street shopping centre. The pedestrian way in this case is inward-looking, with many links over the local roads to other adjoining buildings, as shown in Figure 194. The pedestrian level is ramped down to original ground level at the hospital, at Fitzroy Square, and in the area of older dwellings in the south-eastern part of the site. A family housing area adjoins the district distributor on the west. Its layout presents difficulties because of the high densities and the need to obviate traffic noise. The effects of noise could be reduced by placing a two-storey garage building all the way along the road, with a grassed roof and a wall or bank along the edge. Behind this would be low parallel blocks of houses shielded from the noise, and beyond these would be tower blocks. Figure 193 shows sections through parts of the area adjoining major roads and Figure 195 shows the layout.

Oxford Street

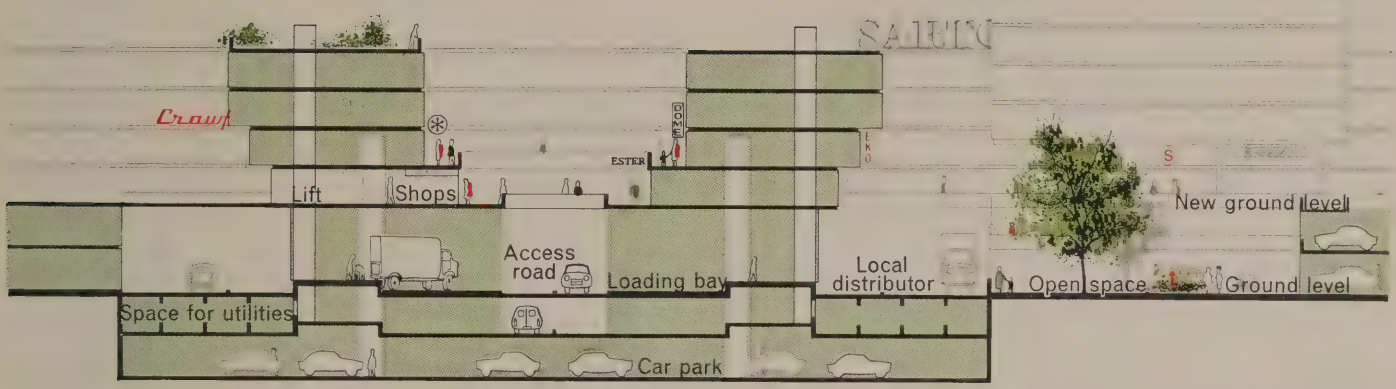
345. The terms of reference we set ourselves permitted us to consider the complete redevelopment of Oxford Street. This would not, in fact, have been wildly out of accord with the possibilities that existed ten years ago,

193 The design for partial redevelopment. Sectional views (for location see Figure 195) showing how development might be disposed to minimise noise from major roads.

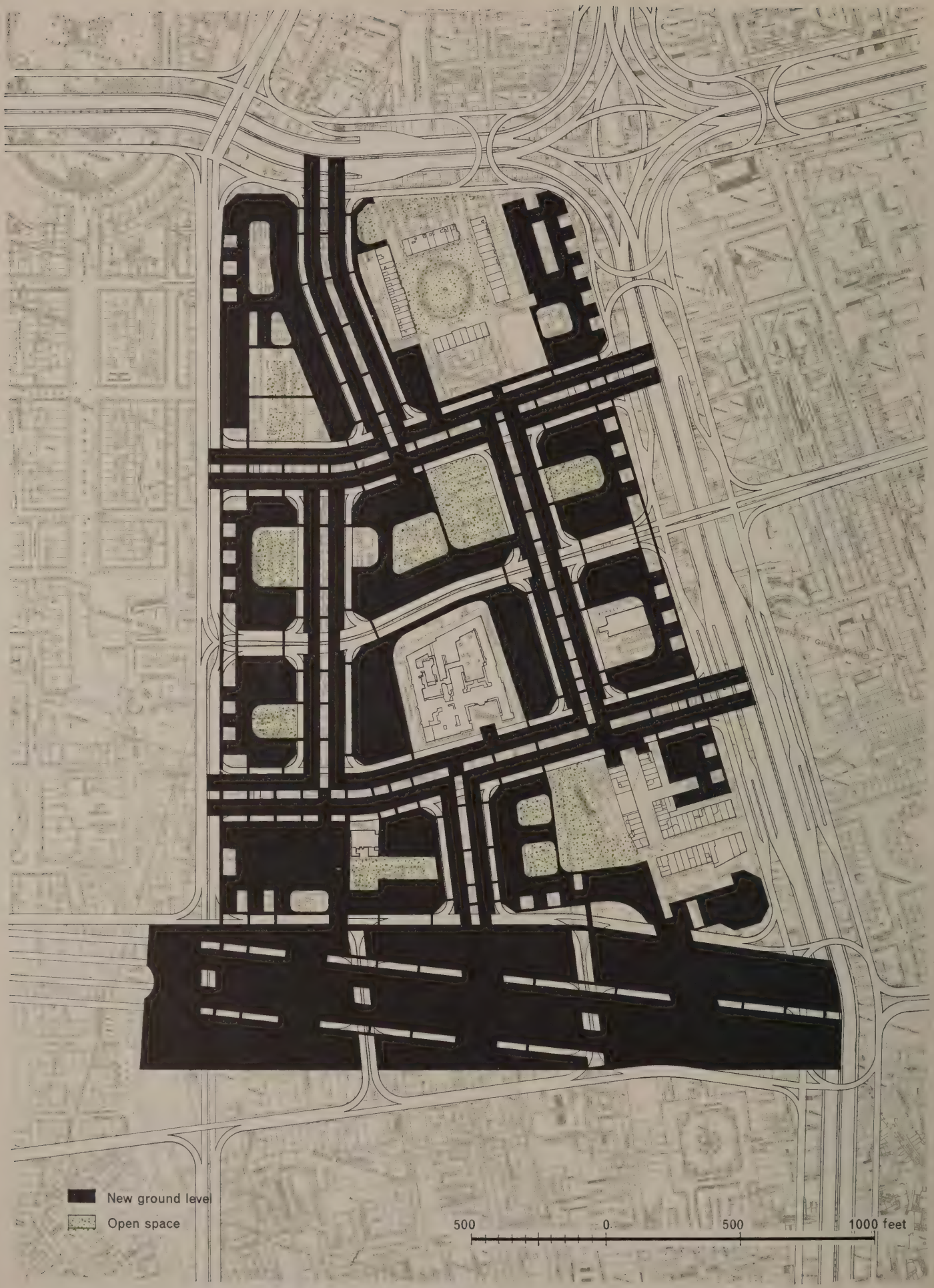


P Car park
R Residential
W Warehouses
Li Light industry

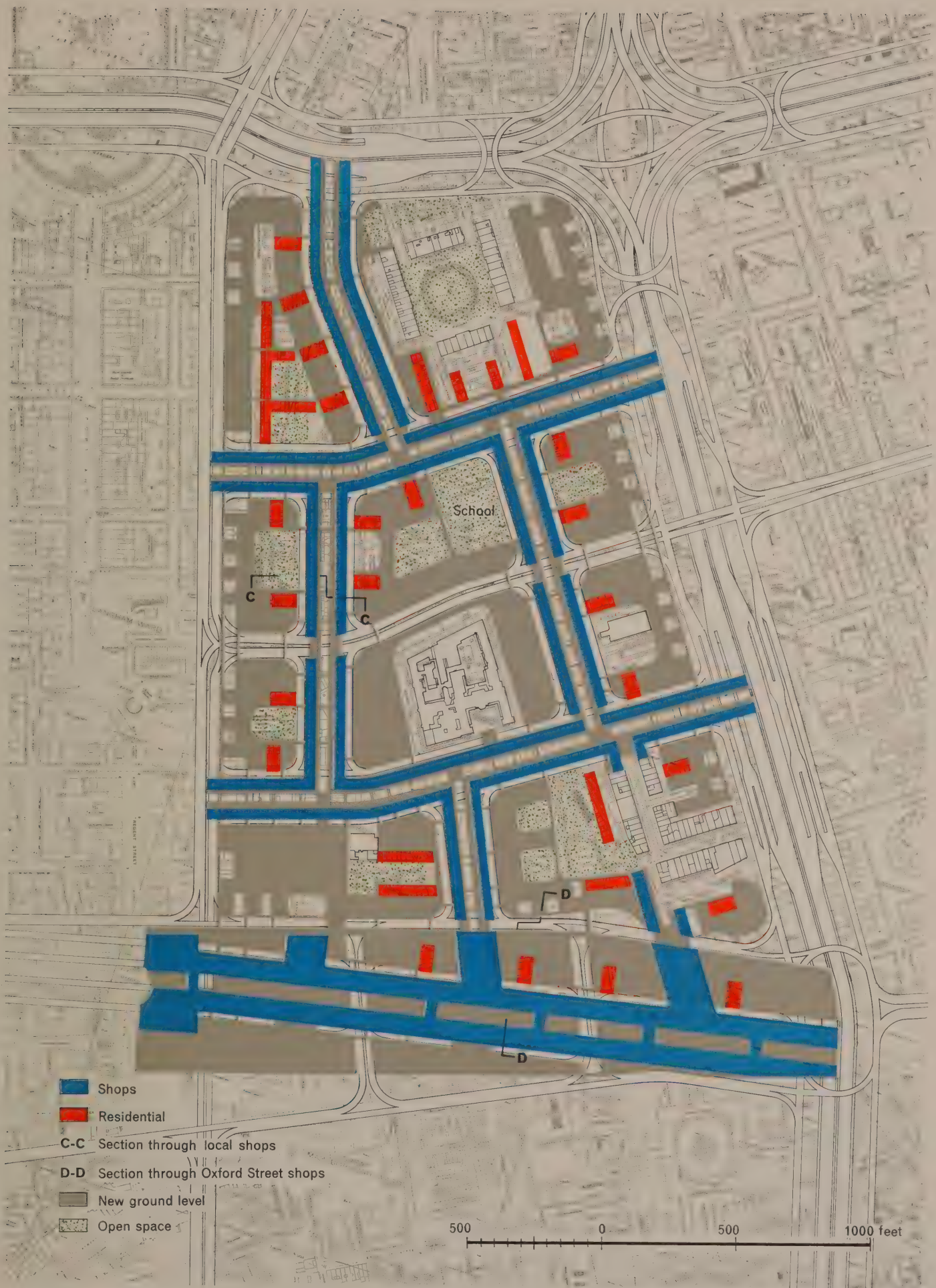
194 Design for partial redevelopment. Section through local shopping corridor (CC on Figure 197).



195 The design for partial redevelopment. Layout plan for the area around Fitzroy Square. The three sectional views (marked 1-1, 2-2, and 3-3) on this plan will be found in Figure 193).



196 The design for partial redevelopment showing existing buildings to be retained at ground level and, in black, the raised deck on which the new building would be constructed.



197 The design for partial redevelopment—plan shows the broad disposition of shopping and residential uses at deck level. Certain buildings are preserved at real ground level. Sections C-C and D-D refer to Figures 194 and 198.

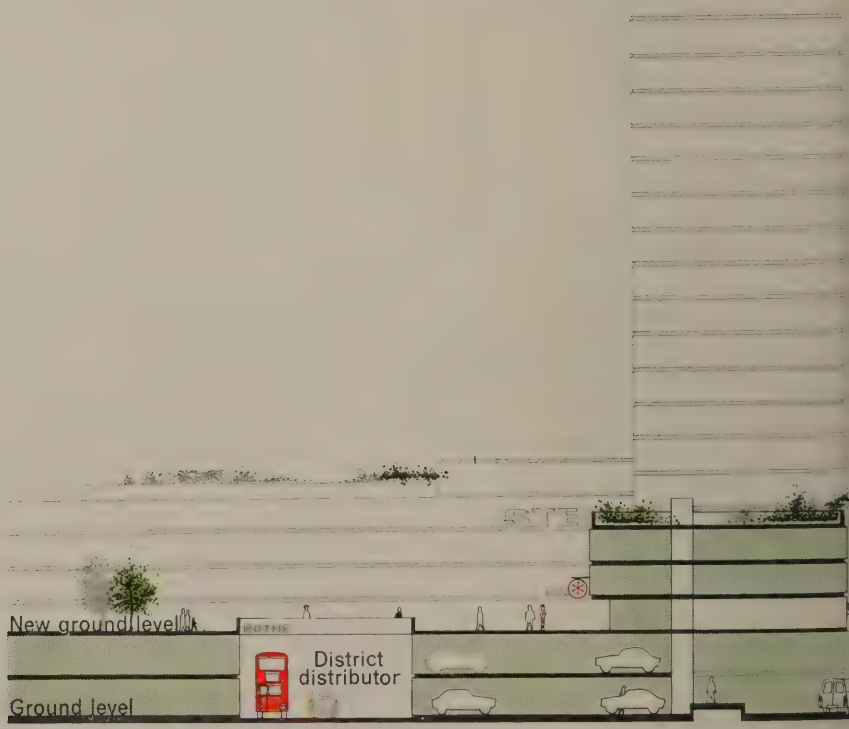
had there existed a plan of action for the street to direct to some coherent overall design the reconstruction which was soon to start. As it is, the opportunities which could have transformed Oxford Street into a first-rate metropolitan shopping centre have been frittered away.

346. We assumed that through traffic in Oxford Street would be removed partly by a regional distributor for Central London and partly by the primary distributors of the grid. The essential design problem then was to contrive the access of cars, buses and service vehicles to the shops, while creating a good environment. Our proposal was to retain the frontages of Oxford Street on their present line, but to create a new pedestrian street at 20 feet above ground level, with service access at ground level, and parking at various levels below the deck. Access for shoppers' cars is by a one-way pair of distributors running parallel with Oxford Street at ground level. The pedestrian level would be continuous throughout the scheme. Behind the main shopping street would be a series of linked squares in which are arranged offices, public buildings, 'bachelor' flats and some shops. (Figure 198 shows the section through the Oxford Street centre.)

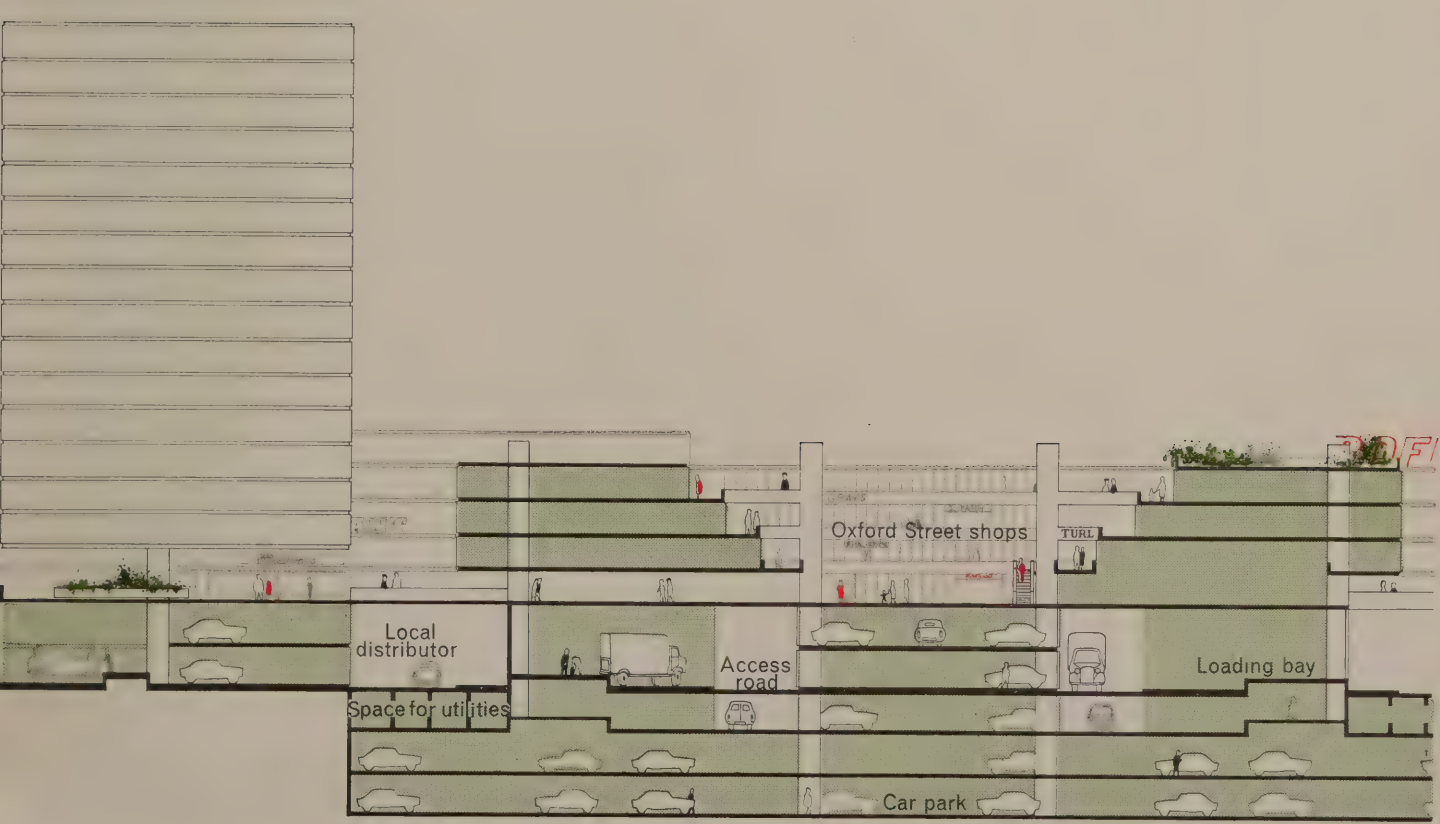
Redevelopment in stages

347. The scheme for 'partial comprehensive' redevelopment outlined here would be capable of being implemented in stages, and also of being executed by a number of developers or syndicates on a number of distinct sites. The whole redevelopment, however, is dependent, ultimately, upon the provision of the primary network whose construction and programming raises very difficult problems.

348. The network in this scheme encroaches to some extent on the study area. It would be possible to undertake the redevelopment of the area in advance of the construction of the network, provided the traffic potential of the area is not allowed to build up beyond the capacity available in the existing approach roads. But obviously it would be short-sighted to delay the construction of the network too long, even if it could not be undertaken without the demolition of some properties in the area. If the area were to be redeveloped concurrently with the construction of the network, then the properties could be replaced in the process. It is a feature of this



198 Scheme for partial redevelopment. Section through Oxford Street shopping centre, showing the district and local distributors and access road at ground level, and the shops at the 'new ground level' above (section DD on Figure 197).


Oxford Street shops
TURL
Local distributor
Access road
Loading bay
Space for utilities
Car park

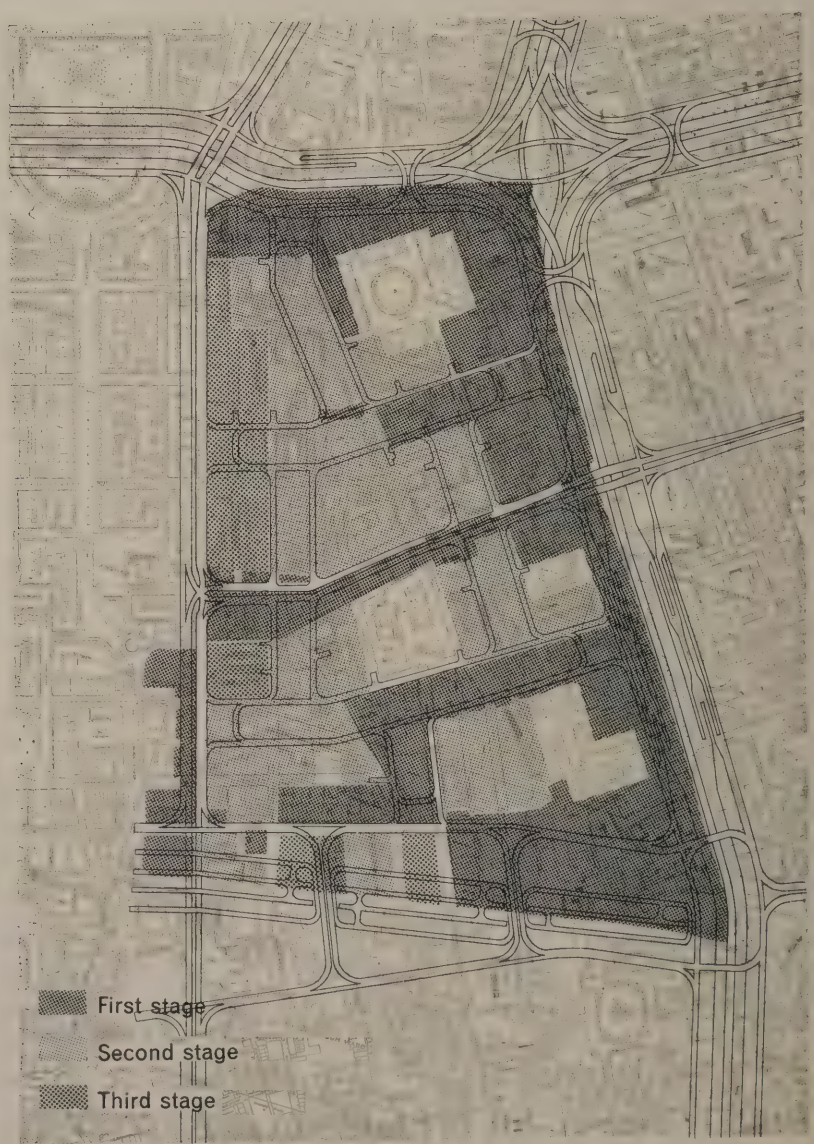
scheme that even though the area is reduced in size by reason of the loss of land to the network, there is no displacement of accommodation. But if redevelopment were to be delayed then some of the uses would have to be replaced elsewhere.

349. To illustrate a possible staging programme, we take the case where the area is being redeveloped concurrently with the road. But we emphasise that events would not necessarily occur in this order in practice. A major road cutting across a standing urban area could not come into existence in time to be of any use, unless it were to be driven forward as one major project with resources concentrated upon it. But it is unlikely that all the adjoining sites affected by the road could be simultaneously redeveloped. Some might even precede it.

350. As we have visualised it, the first stage would cover the construction of the primary network and the district distributors, together with the redevelopment of the war-damaged areas in the north-eastern part of the site, and the area of obsolete layout in the south-east. For these purposes 71 acres or 48% of the whole site would be needed, but about half of this amount would be taken up by the major distributors.

351. To keep the possibility open of re-organising the area, it would be essential, all through the operation, to prevent the piecemeal rebuilding of small sites by private and public developers.

352. The area dealt with in the second stage, covering 47 acres or 32% of the whole, derives from an examination of the age and condition of property, and from a study of the location of sites where applications for planning consent by individual developers have been made. The third



199 The stages by which redevelopment might take place. The first stage covers the primary and district distributors, the second stage the older properties, and the third stage the substantial properties in Great Portland Street and Oxford Street.

stage covers 18 acres or 12% of the area, and covers the substantial properties in Great Portland Street and Oxford Street. Buildings and groups of buildings to be preserved account for 12 acres or 8% of the area. Figure 199 shows the three stages of redevelopment. Figure 200 shows how the road system would be arranged at the end of the first stage.

The need for redevelopment in large sections

353. These are the main stages. For the actual process of redevelopment the area could be divided into about thirteen groups of consolidated sites which could be undertaken by different owners or syndicates. These sites would vary in size from 5 to 14 acres (Figure 202). Big sites are absolutely essential for the following reasons:

(i) To allow construction of the new local distribution system. This partly makes use of existing roads, and partly relies on new roads being constructed as redevelopment occurs. If sites are too small the new roads could be built only in small sections at a time, and the insertion of new access roads, necessary to allow existing roads to be used as distributors, is impracticable.

(ii) To facilitate the creation of the new pedestrian level. If sites are small and scattered, a most inconvenient interim stage occurs with old and new buildings (and therefore pedestrian circulation) at different levels.

(iii) To make possible the large scale re-arrangement of uses that major road works on such a scale would necessitate. For instance, the building of the primary distributors would displace a large number of shops and businesses. Large new sites are needed to re-accommodate them in a way that will fit in with the ultimate plan.

200 The roads as they would be at the end of the first stage. Where the roads fall outside the blue tint it indicates that use is made of existing streets.

201 Fitzroy Square. The square and the surrounding buildings form a valuable group worthy of preservation.

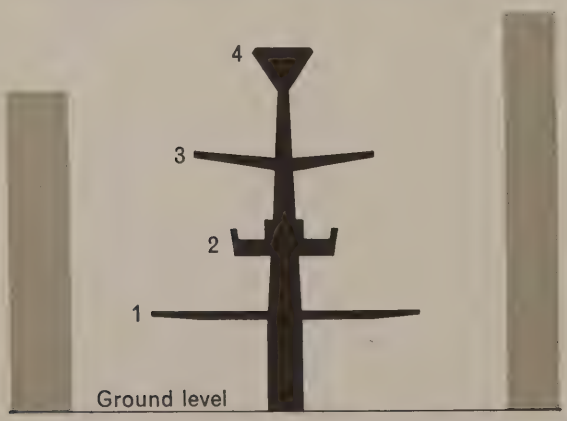
202 The separate consolidated groups of individual sites which could be redeveloped by different owners or syndicates.

203 The scheme for partial redevelopment as it might be in the vicinity of Fitzroy Square, looking north. The square is mainly converted to pedestrian use. In the foreground the pedestrian level rises to the upper levels predominant through much of the scheme. The lower pedestrian bridge in the foreground has a reduced clearance since the road it spans gives access to a car parking area only. This is a departure from normal practice which would require careful consideration, but there is no doubt that economies would result if clearance heights could be reduced on occasion. In the United States the *general* clearance height is 14′ 0″ compared with our standard of 16′ 6″.


THE CROWN
FITZ

204 Colville Place. A good existing example of a pedestrian residential street.

205 The Street Market in Great Titchfield Street.



206 The proposal by Mr Rigby Childs for a free-standing pedestrian walk in Oxford Street. This is a cross-sectional view with existing buildings on either side. The ground level would be wholly available for two carriageways of traffic. Level 1 is the pedestrian platform. Level 2 is the two-way travalator with canopy over at 3. At level 4 there is a longitudinal structural member for stability.

*See *Architect's Journal*, 23 March, 1961

The third study: minimum redevelopment

354. For our next exercise we decided to restrict redevelopment to the absolute minimum and to see what the consequences of this would be for accessibility, whilst endeavouring to secure reasonable environmental standards.

Assumptions regarding through traffic

355. We assumed:
(i) that through traffic in relation to the central area of London had been removed by some kind of regional distributor; and
(ii) that a primary distributory system for the central area had been devised, of which the roads bounding the West End were part. These distributor roads would have six lanes, undivided, and a variety of intersection types including an occasional two-level arrangement. It would in fact comprise the sort of road system that is emerging gradually at the present time as a result of various individual improvements. Tottenham Court Road and Euston Road bounding the study area to the east and north, would, we assumed, form such distributor roads.

Environmental areas

356. A study of the way the area is used at present (Figure 165) shows that there are six potential environmental areas:

(i) The Oxford Street shopping area
(ii) The clothing trade area immediately north of Oxford Street
(iii) The Hospital
(iv) The Charlotte Street-Percy Street restaurant area
(v) Fitzroy Square and surrounding streets
(vi) The Great Portland Street–Titchfield Street area of mixed business and residential uses, with a busy local shopping centre and market.

Local distribution

357. Figure 208 shows streets capable, from the point of view of their width and layout, of acting as local distributors. These are Great Portland Street, the Howland Street–Cavendish Street route, the Goodge Street–Mortimer Street route, with Charlotte Street and Berners Street possibly playing a part. It was also evident that it would be difficult to avoid the retention of Oxford Street and the Portland Place–Regent Street route as internal distributors for the West End as a whole.

Oxford Street

358. These conclusions at once brought up the question of Oxford Street in an acute manner. How could this street act both as a distributor and also as a major shopping street? There appeared to be only one answer to this dilemma, namely to raise the pedestrians and (ultimately) the shopping frontages above the vehicular traffic in some manner. An ingenious idea by which this might be done was recently put forward by the architect Mr D. Rigby Childs.* He proposed the erection of an elevated free-standing pedestrian mall down the centre of Oxford Street for its full length (Figure 206). It would comprise a platform, cantilevered out from central columns, and standing about 20 ft. above existing road level. It would not reach out to the façades of the existing buildings but would stop short by about 15 ft. The closing of the gap, thereby providing pedestrian access to the buildings at first floor level, would be a matter for each frontager to decide in the knowledge that, once the structure had been erected, a strictly limited period would elapse before all pedestrian movement was transferred to the upper level, and the existing pavements absorbed into the carriageway to provide more space for traffic. The total cost of the project, including a roofed-over travalator for the full length of Oxford Street (1·2 miles) is estimated to be of the order of £12 millions.

359. It could not be claimed for this proposition that it would give as good a result as if the reconstruction of Oxford Street had been tackled comprehensively before the present piecemeal reconstruction began after the war. But it would certainly produce pleasant, indeed unique shopping conditions, and if only minimum redevelopment is contemplated it seems to be the only course now available for the rescue of the street from the confusion into which it is falling.

The plan for minimum redevelopment

360. The broad proposals for land use and internal distributor and access roads are shown in Figure 209. With the exceptions of short lengths at the east end of Oxford Street, the west end of Mortimer Street, and at the east end of Howland Street, no road widenings are necessary to implement the scheme. As far as possible, roads selected to act as district distributors do not sever the embryo environmental areas. In general, however, conditions on these distributors would not be satisfactory until redevelopment had made possible the removal of frontage uses that generate heavy pedestrian traffic—removal, that is to say, either to an upper level or away from the street frontage altogether. Rigorous control of redevelopment would have to be exercised along the whole of the distribution system to ensure that the sites redeveloped were large enough to enable the separation of pedestrians and vehicles to be achieved, and to secure vehicular access to buildings. Special difficulties are presented by Regent Street which needs to be dealt with as urgently in this respect as Oxford Street, but in view of its architectural character, any proposal to erect a structure along the centre would require the most careful consideration.

208 Capacity of existing roads; showing roads which would be capable, on the basis of their predominant width and alignment, of acting as distributors.

207 Charlotte Place looking north to the new Post Office tower under construction.

Traffic capacity

361. On the basis of this plan we calculated that the maximum permissible traffic generation in the study area could be of the order of 3,400 p.c.u. per hour. For this calculation we assumed a lane capacity of 500 vehicles per hour for the local (West End) distributor roads, and twelve points of connection (signal controlled) between these roads and the surrounding major distributor.

Access to buildings

362. We next had to check that this volume of traffic could be handled by the arrangements for access to buildings and parking. We concluded that it could be done, but that within the environmental areas it would be necessary, on certain roads, to combine to a limited extent the functions of local distributors and roads giving access to buildings. We also concluded that, pending redevelopment, it would be necessary to use one side of all mews, access roads, and access-distributor roads for the servicing of the buildings along them. This would make movement on these roads difficult but not impossible. It precludes, however, any on-street parking of cars.

Allocation of the parking places

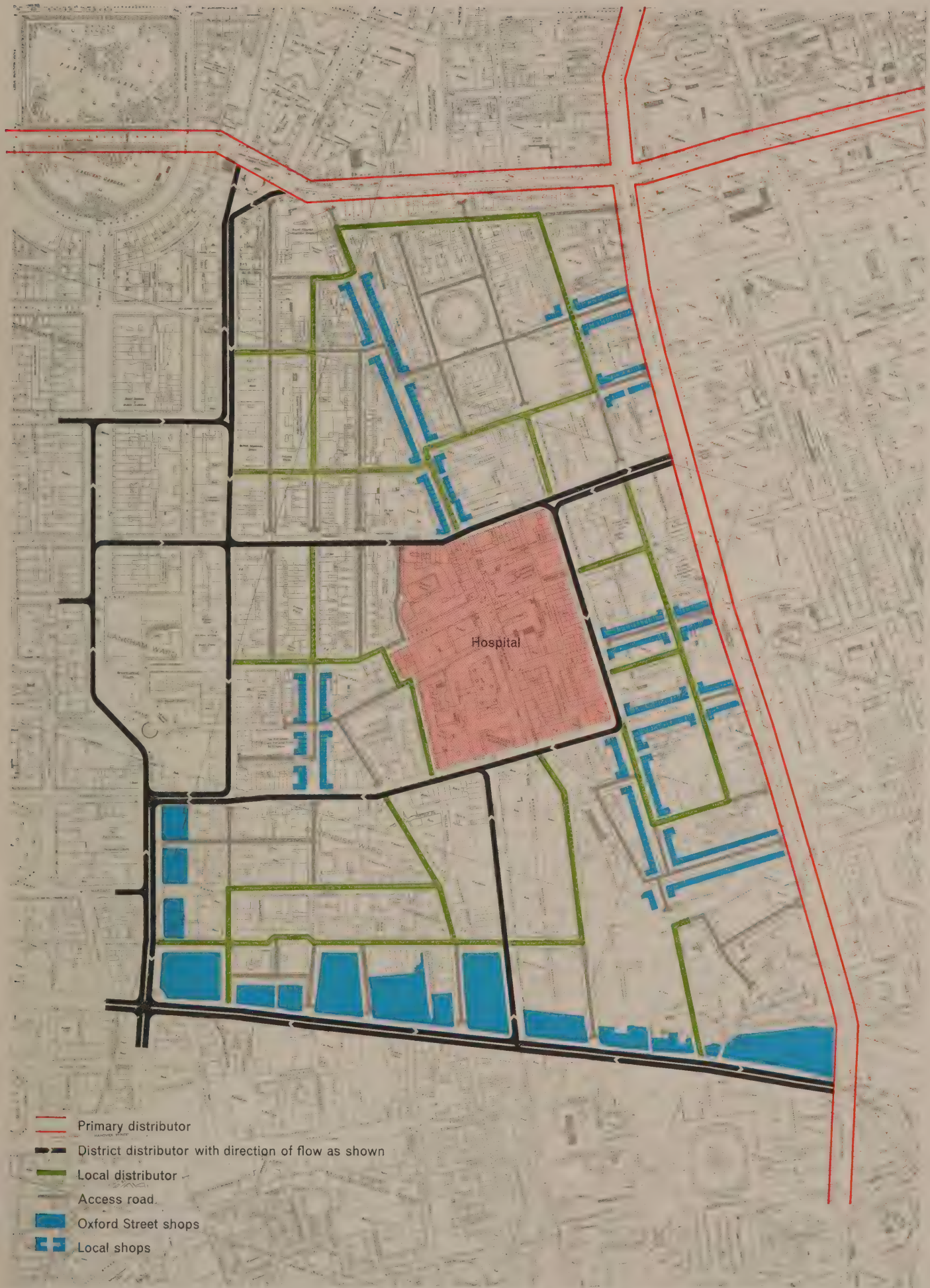
363. We first looked into the situation at present and determined the 'spare' capacity for optional traffic over and above that required for the essential traffic which is generated. We then concluded that any provision of car parks for optional traffic could be only temporary as eventually the whole of the road space available would be taken up during the peak-hour by the increased generation of essential traffic. We estimate the present essential traffic peak-hour flow to be around 1,000 v.p.h. This is approximately 8% of the estimated 13,500 total daily essential trips. Of these we assumed $\frac{1}{3}$ involve cars and $\frac{2}{3}$ vans and lorries, so that about 4,500 cars and 9,000 vans, etc., visit the area daily. The parking and loading facilities for these we calculated on the same basis as before. Cars used for essential purposes need 750 spaces. Vans and lorries need 1,400 loading bays or spaces. Essential parking could in theory be accommodated in the existing off-street parking spaces of which there are some 1,300, but some of these are in the north of the area and may not be conveniently placed in relation to business premises.

364. With the above level of essential traffic movement, there would be room for some optional traffic, and about 2,250 parking spaces could be provided. Total car parking requirements would therefore be 750 essential and 2,250 optional—a total of 3,000 spaces. Taking into account the 1,300 existing off-street spaces, about 1,700 additional spaces would have to be provided if the maximum generation is to be taken up.

365. This provision would allow rather less than 5% of all shoppers and workers coming into the area to travel by car. In the long run, however with the estimated peak hour flow for essential traffic standing at 3,800 p.c.u./hour, and the total hourly capacity restricted to 3,400 p.c.u./hour, it is obvious that it will not be possible with this scheme to cope even with all the essential traffic that might ultimately be generated. It follows that, unless commercial movements are severely restricted during the peak period, any parking spaces to be provided in the near future for optional traffic would best be of a temporary nature only.

Conclusion

366. Our general conclusion from this exercise is that 'minimum redevelopment' is a somewhat misleading concept. In fact, even within the modest scheme we have outlined, the amount of redevelopment that would be necessary would be considerable if reasonable environmental conditions are to be established. It would be necessary, first, to redevelop comprehensively the sites adjoining the primary distributors serving the West End (i.e., in relation to the study area, Tottenham Court Road and Euston Road). This would really need to be done at the same time that



209 The plan for minimum redevelopment. The district distribution system is partly one-way and partly two-way, based largely on the capacity of the existing roads. All other roads are two-way.

these roads are converted into primary distributors. Secondly, it would be necessary to hold up the redevelopment of the frontages on other distributors until large enough sites had been secured to make it possible, on redevelopment, to separate vehicles and pedestrians. Thirdly, a major 'rescue operation' would be required for Oxford Street. Given all this, the area could be made to function reasonably efficiently and with a tolerable environment, but the usage of private cars (other than for residents) would be restricted from the very first, and would become progressively more and more restricted. (Figure 210)

210 The scheme for minimum redevelopment. This figure shows the areas which would, in fact, require comprehensive redevelopment, and the frontages where redevelopment would need to be controlled in order, eventually, to separate pedestrians and vehicles.

The fourth study: piecemeal redevelopment

367. At the present time the London County Council require the provision of a standard amount of parking space in all new buildings as a condition of planning consent. Many other cities are now following the same practice. We were interested to see where this policy would lead on the assumption that the study area was allowed to redevelop 'naturally' by the piecemeal reconstruction of individual buildings, on their present sites, each with its own parking facilities. The Council's regulations for parking space are complicated, but as an example, the standard for offices requires one car space for every 2,000 sq. ft. of gross floor area of a building.

368. The Council's standards, if applied to a complete piecemeal reconstruction, would produce about 5,500 parking spaces for non-residential buildings, and 1,500 for residential use. These figures may be compared with our estimate of 2,000 spaces required (in 2010) for *essential* car traffic alone, plus (in our partial redevelopment scheme) the 8,500 spaces available for commuters and shoppers, to say nothing of the 5,000 spaces for residential use.

369. The parking space that would gradually accrue as a result of the official standards would meet the ultimate needs of essential traffic, but it would not necessarily be of the appropriate kind. The balance available for commuters and shoppers would enable about 4% of the persons in these categories to use cars. Any further provision for commuters and shoppers would presumably have to be provided in the form of special parking garages, but the emergence of these is an entirely haphazard process at the moment. On the other hand we have demonstrated (para. 322) that even with a proper primary distribution system, only about 30% of the demand of commuters together with 60% of the demand by shoppers etc. could be met. Thus, if parking garages were proceeded with regardless of other considerations, there could result a serious imbalance between the amount of parking and the ability of the local streets and the network to handle the resulting traffic. This is confirmed by the fact that our estimates show that, with the type of network at present being implemented (described in para. 355), there will hardly be sufficient capacity for the ultimate level of *essential* traffic. So even if no additional parking garages were provided, the application of the parking standards, low as they are, would eventually lead to an overloading of the road system.

370. As to the parking provision for residential uses, the official standards seem likely to lead to a severe under-provision. It could be argued, as it often is, that people who live so close to the centre of London should not expect to have the convenience of cars, but we think this is misjudging the situation. We think people may have to be told fairly firmly where, and when, and how they can *use* their vehicles, but we feel sure they will demand the right of *ownership*, along with the use of a garage or parking space, wherever they live, and that they will not be greatly deterred in this by such restraints on usage as may be necessary. Once again, however, there could be serious difficulties if ownership built up without the accompanying provision of a proper network. The usage of cars from a central residential area such as this would not, however, contribute greatly to normal peak periods, but it would do so to a quite different peak period —the homeward rush from coast and countryside on Sunday evenings.

General conclusion of the four studies

371. It may be thought that the first two of the studies described in this section, including the elaborate network upon which they are based, are so far beyond the bounds of practical possibility as to have been not worth undertaking. To this we would reply that our primary concern has been to demonstrate the facts, and to show how much traffic can be accommodated for various degrees of reconstruction and elaboration of network. If it is held that the examples go beyond practical possibilities, then, if less elaborate schemes are desired, it follows inevitably that means must be found to restrict even further the usage of vehicles. However, although the opportunities for radical reconstruction seem to have been lost in the area under discussion for a generation at least, there are plenty of other areas where there is still great scope. In such areas, looking ahead and having regard to the rate of technological advance and the rising standard of living, we think schemes on the lines we have explored are far from being unrealistic.

211 The pedestrian centre at Stevenage New Town.

Chapter IV: Some lessons from current practice

372. There is a great deal of interesting work being done in various parts of the world, but for the purposes of this chapter we have restricted ourselves to examining certain aspects of practice in this country, some examples from Europe, and (most importantly) a broad look at the course of events in the United States.

Britain

The New Towns

373. Two obvious developments for us to examine were the New Towns and the reconstructions of the bombed cities, these being the two great urban enterprises in Britain since the war. We found the New Towns not unimpressive in their arrangements for dealing with traffic, though it was quite obvious that in most cases there had been a serious under-estimate of the rate of growth of car ownership. Most of the towns seemed to start off with a garage ratio of about one to every four dwellings, a figure which is now being generally altered to one to one. We think it is correct to say that in none of the first batch of new towns commenced after the war did the designers consciously say to themselves 'Nearly all the people living here are going to demand motor cars in the foreseeable future, and the right to use them, so what sort of a town ought we to design to enable them to do so?' Nor, so far as we know, were any of the towns designed with a serious attempt to forecast the traffic movements that various ways of arranging the buildings or activities would generate.

374. In spite of this, the layout of the New Towns has a number of clear advantages over our older towns. The fairly simple clear-cut groupings of the main uses—residential areas, industrial areas and central shopping and business areas—have made for simple movement patterns with longer journeys concentrated onto clearly defined networks. The residential areas have been carefully protected from flows of through traffic or cross-filtration by drivers seeking short-cuts. In the town centres, always the most difficult problem, a variety of interesting layouts has been produced. They were all designed to provide pleasant and efficient surroundings free from domination by motor traffic. Stevenage is perhaps the most significant, with its central square and narrow shopping alleys quite free from vehicles.

375. Even though the approach to design has been intuitive, the 'first generation' New Towns all reveal a structure of the environmental area-network type, and it seems to work well enough at present. There must, however, be some doubt whether these towns, when put to the test that conditions of car ownership at the end of the century will impose, will function satisfactorily. The parking problem and its effect on environmental standards is likely to be acute in both residential and central areas, in spite of their present comparatively low density; and even if the road systems prove adequate for the flows that will be imposed, some deterioration of their present high standard of environment may be unavoidable. We were able to conclude from our study of Newbury that it would be possible, in a town of that size, to give people all they might want in the

212 The New Towns—a major urban enterprise.

way of vehicle usage, though at a considerable cost, but we could not conclude from the evidence of the earlier New Towns, *as planned*, that the same would hold for towns in the 60,000–80,000 range of population.

'Second generation' New Towns—Cumbernauld

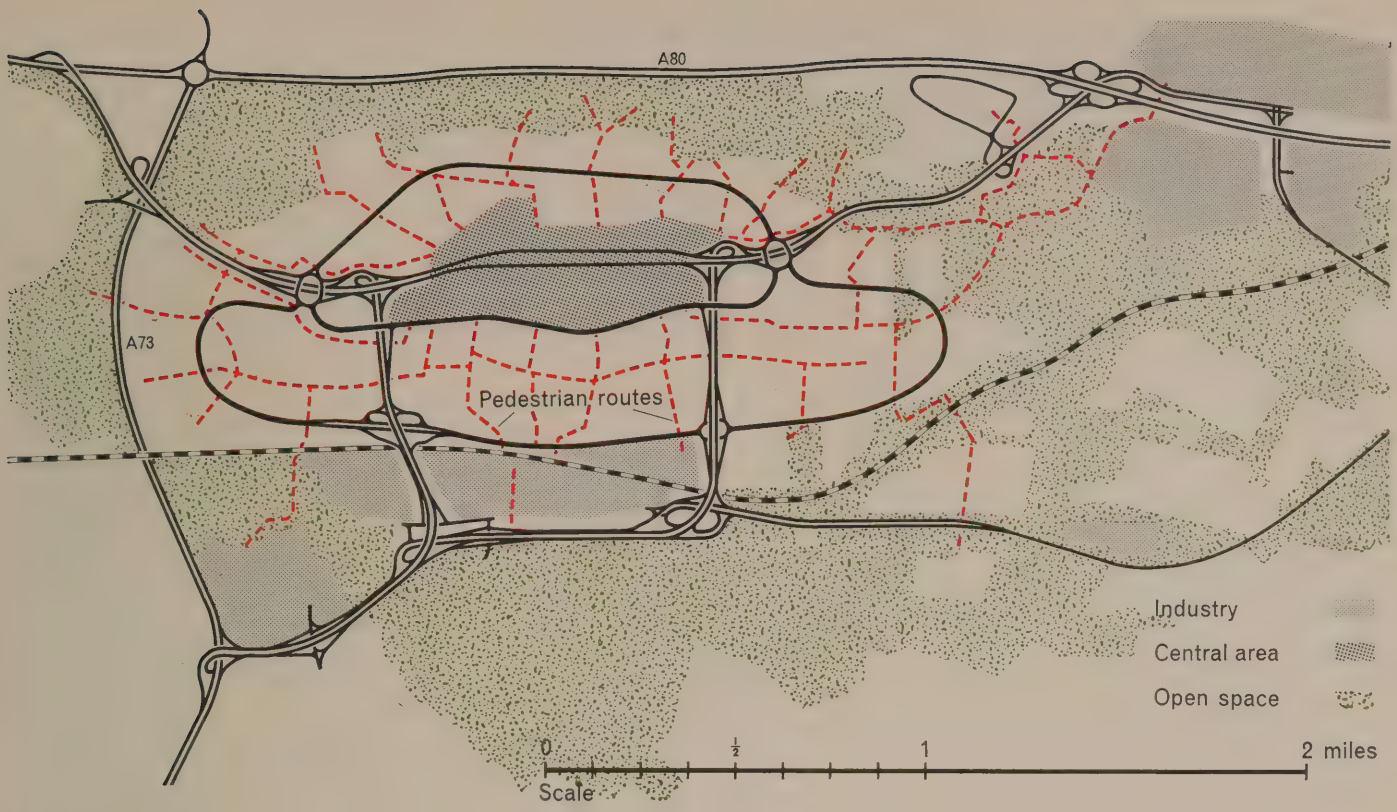
376. We turned from the 'first generation' New Towns with some doubts of their capacity to withstand the onslaught of full car ownership to look at the first of the 'second generation'—Cumbernauld, in Scotland, a town expressly designed 'to master the motor car'. This is a town with a planned population of 70,000 which is being built to assist the relief of overcrowding in Glasgow. The great interest of the case is that it was the first example in this country of a serious, systematic attempt to elucidate the relationship between activities and traffic.

377. The preliminary studies started with a tentative plan which was then, as it were, tested to destruction. This plan was conventional in character, with radials and outer and inner ring roads, in principle not unlike the plans of the earlier New Towns. When this plan was tested, however, by methods somewhat similar to those employed in our own study of Newbury, it was found that staggeringly high volumes of traffic would build up on certain parts of the network, particularly on the inner ring road. It is not necessary to follow through all the steps of the analysis; it is sufficient to say that when all adjustments and counter adjustments had been made, the plan that emerged was strikingly different from all the plans of the earlier New Towns. The road network is shown in Figure 213. It is generally of a simpler pattern than in the earlier New Towns, and in relation to population there is a lower mileage of main road. But the principle of concentrating as much vehicular traffic as possible on roads specially designed for free flow and safety and giving very little choice of route, does mean that the network consists of high-powered roads of near motorway standards with elaborate intersections. This is exactly what we found in the study of Newbury.

378. The plan for the central area is a particularly interesting feature of Cumbernauld. This is of linear form, built on a deck *above* the approach road. The idea of an inner ring road encircling the central area has completely vanished. The shops and business premises are to be built on the deck with a number of dwellings on the top again. Thus cars, buses and service vehicles are brought in *underneath* the shops but in very close proximity thereto, and complete separation of vehicles and pedestrians is obtained. Such an arrangement of course necessitates the use of escalators. It is as though the pedestrian centre at Stevenage had been jacked up 20 ft. and the surrounding car parks and ring road pulled in underneath. Ground space is saved, and the bleak parking and service areas are drawn in out of sight.

379. Yet Cumbernauld is by no means designed for motorised movement and nothing else. In addition to its good accessibility the design seeks to establish an equally good environment. A deliberate feature has been a general concentration of development as compared with the earlier New Towns, partly with the object of facilitating pedestrian movement, especially to the centre. In Figure 213 the main pedestrian ways are indicated. It will be seen that the whole town is, in a sense, a gigantic Radburn layout. The *vehicular* approach to the centre is circuitous, usually necessitating a journey out and round and then in along the road under the centre. The *pedestrians'* approach, via a completely separate system of footways, is direct.

380. The Cumbernauld plan is based on a car ownership level, in the fully developed town, of one car per family. Up to that level it may be assumed to give all the freedom of car usage people are likely to want. But there now seems every prospect of the level rising a good deal higher than this. So the plan itself does not establish that a town of 70,000 people could be designed to cope with full car ownership, but our assessment is that with certain alterations in layout it would be possible. But it has to be noted



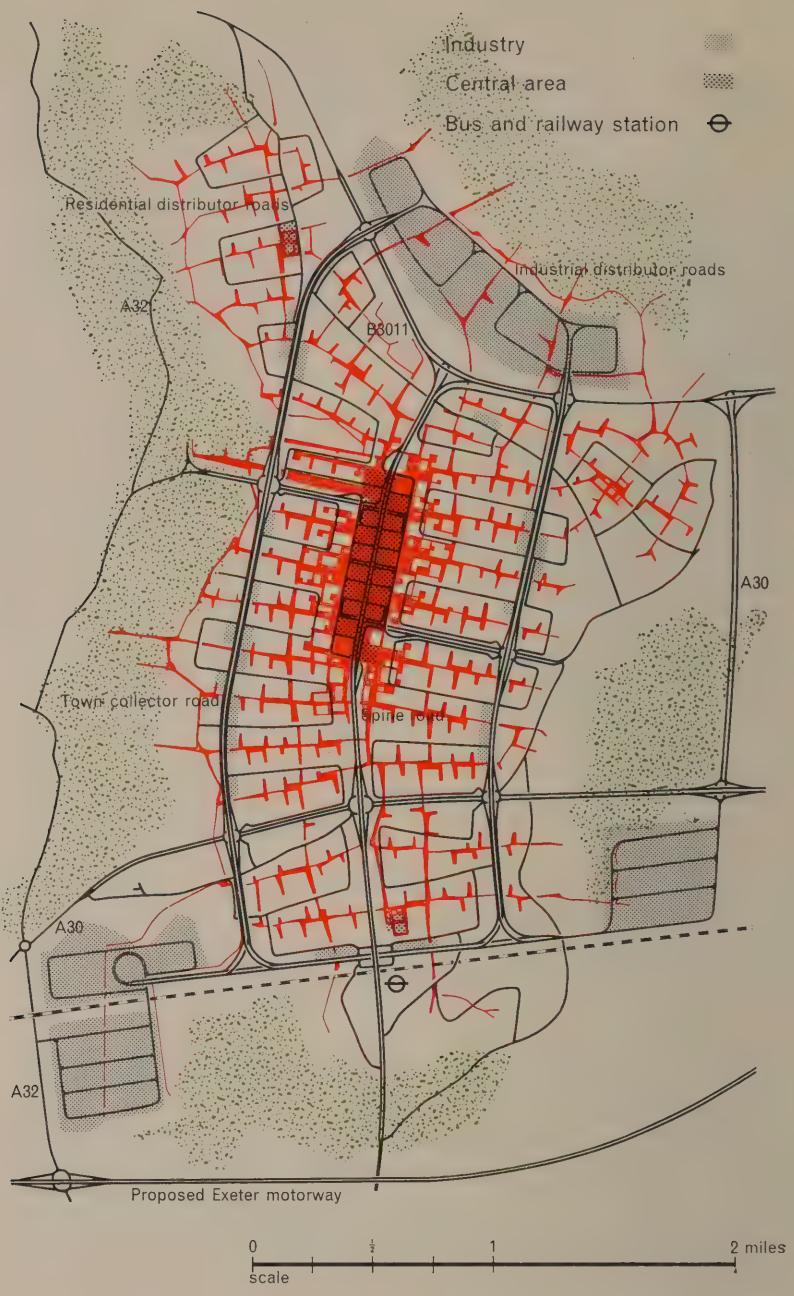
213 Cumbernauld New Town. The primary network showing the independent pedestrian routes filtering through the residential areas to the elongated town centre. Note the high-powered character of the network, with the main link passing underneath the centre.

that this is a design for a *new* town, with all the advantages inherent in designing on a clear site. To remodel an *existing* town of this size for the full potential ownership and usage of cars would be much more difficult and costly, but we think physically it could be done.

Hook

381. In order to establish what level of car ownership can reasonably be designed for, we next examined the London County Council's project for a new town at Hook, a scheme which was worked out in some detail, though never built. This, if not a clear derivative of Cumbernauld thinking, was certainly inspired by the same desire for a plan based on a proper understanding of traffic movement. The plan once again is a huge Radburn layout, with an independent pedestrian system gravitating direct to the decked town centre (Figure 214). The planned population in this case was 100,000, and the basic assumption was that 'private cars will be the main means of personal transport . . .' The road plan was calculated on the basis of 1·5 *cars per family*, which is considerably higher than the figure used at Cumbernauld, and somewhat higher than the figure at present obtaining in California. So this design purports to show that it is possible to provide for a very high level of vehicle ownership and usage in a town of 100,000 population, provided it is purpose-designed from the start. But the whole form of the town is so startlingly different, that there must be a large element of doubt whether an existing town of the same size could be successfully adapted to give the same standards of motor usage. Certainly the cost and disturbance would be very great.

382. It should be noted, to avoid misunderstanding, that even in the case of Hook, in conditions of full car ownership and usage, it was considered that a bus service would still be required. This was for the benefit of the not inconsiderable proportion of families who would not have cars, and for young, old and disabled persons, and for the convenience of other members of one-car families when one member has the car. The Report on Hook did not make it clear whether a bus service in these conditions would be economic. We doubt whether it could be so, and it is possible that some other kind of transport service, such as the cheap taxis that operate in parts of the United States, would be a more attractive proposition.



214 The plan for Hook, a project for a new town commissioned by the London County Council. Note the powerful character of the primary network, and the completely independent system of pedestrian routes shown in red. The nomenclature on the plan is that of the official report on the project.

383. The Hook scheme provides a good demonstration of the working of the 'law' referred to in Chapter II (para. 116). High environmental standards, with great convenience and pleasantness of scene for pedestrians, were decided upon as initial objectives. Consequently, in order to secure a high level of accessibility, complex architectural and engineering forms are required at high cost.

Basingstoke

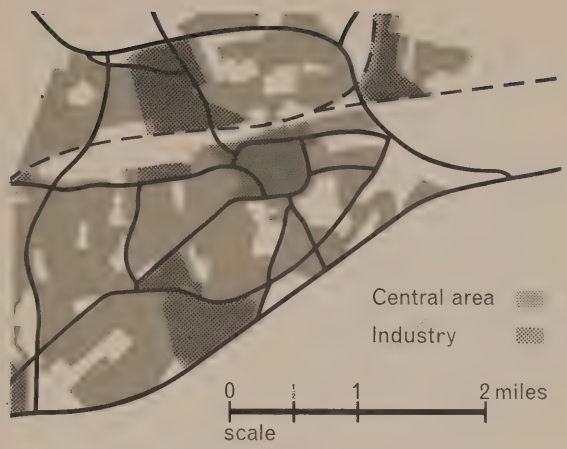
384. Seeking to learn more about the problem of *existing towns*, we examined the proposals drawn up for the expansion of Basingstoke. The proposition here is to expand the town from its present population of 26,000 to 75,000, to receive population from London. In addition there is a dependent rural population of about 30,000 to be catered for. In the evaluation of the design a conventional plan for inner and outer ring roads superimposed on the existing radial system was first examined. This was discarded when it was realised that it would require the extremely expensive widening of the radial roads, all of which have frontage property with direct access (Figure 215). Nor was it possible—and it is a common difficulty with all such proposals—to find an alignment for the inner ring road which did not involve serious severance and destruction of property. A new approach was then tried based on a careful study of traffic movements, and on a delineation of the various parts of the town possessing an 'environ-

mental value' to help decide the location of the new network roads, and without any preconceived ideas about inner rings, or indeed any geometrical patterns.

385. The agreed plan is shown in Figure 216. It will be seen once again that a giant Radburn design has emerged, consisting of a grouping of environmental areas served by a comparatively simple primary distribution network which canalises all the longer journeys, draining the main traffic flows away from the habitable areas. The approach to the town centre is strictly disciplined and is confined virtually to one transverse road. The price to be paid for this concentration of traffic onto a few purpose-designed roads is that the roads themselves are of high standards with elaborate intersections, and of course very expensive.

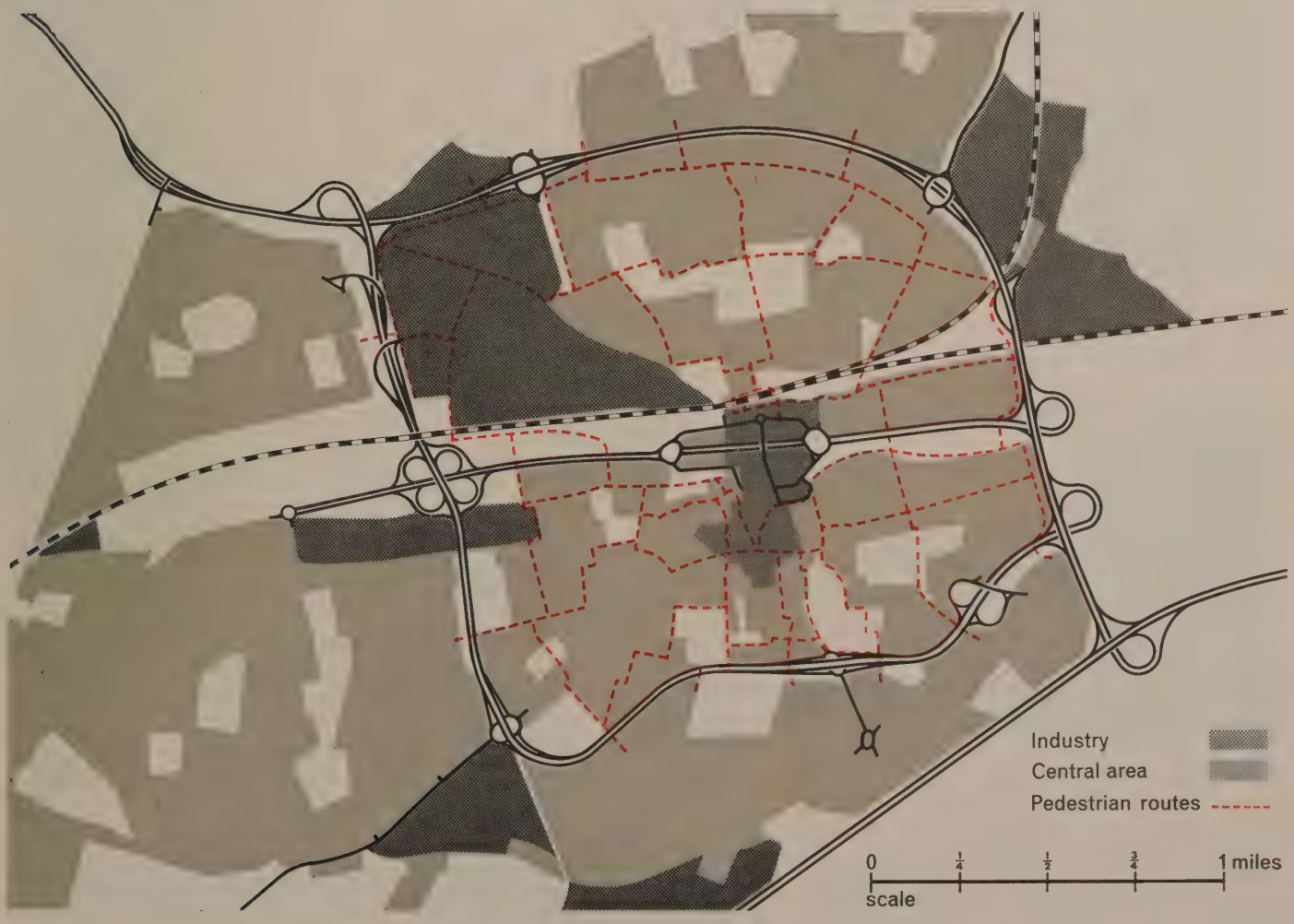
386. The proposals for the central area provide for a virtually new centre north of the existing one. To provide the necessary space at reasonable cost it was found necessary to build it on a deck above the natural valley. Underneath this, two levels of car parking will be provided, with access from the town centre approach road. There will be 6,000 central area parking spaces. An ingenious system of construction is proposed for the deck: it will be hollow in order to accommodate ducts and services, and strong enough to enable the buildings upon it to be freely laid out largely independent of the layout for traffic below. On the deck a complete, intimate, pedestrian area will be created. As at Hook and Cumbernauld the advantages of two-level planning for both accessibility and environment are strikingly demonstrated.

387. This, of course, is not strictly a case of a design for an existing town, since the great increase of the population does introduce an element of 'new town' opportunity. Nevertheless all the central part of the town is closely developed already, and the case can be taken to show that for a town of 75,000 persons, it is probably possible to provide for most of the motor usage people are likely to require so long as works of a considerable magnitude are undertaken.



215 Basingstoke. This is the first plan, based on conventional ring roads, which was tested as the basis for expansion and redevelopment. It may be compared with Fig. 216 which shows the plan finally adopted after full analysis of traffic movement and environment.

216 The agreed plan for Basingstoke expansion. In principle it resembles the Cumbernauld and Hook plans with a very clearly defined primary network with a cross-link passing underneath the central shopping area. An independent footpath system gives pedestrian access to the centre.



The bombed cities

388. When we examined the blitzed-city reconstructions we found a generally disappointing picture in the failure to develop adequate environmental concepts, though Coventry, Barbican in the City of London, and the large reconstruction in London's East End (Stepney-Poplar), are notable exceptions. It seems as though there was difficulty in visualising the way traffic would build up and the ferocious impact it would have on urban surroundings, particularly in town centres. It is perhaps understandable—for several years there had been very little traffic on the streets, and the bedlam people had become accustomed to was the bedlam of war and bombing. The bedlam of traffic, apart from the convoys, had been forgotten. Indeed, when traffic of more substantial volume developed, the bedlam was even pleasurable, as it offered a continuing reminder of the end of the war.

389. Looking at the matter practically, however, the two main mistakes seem to have been the advocacy of the double-carriageway street as the standard form for main shopping areas, and the reliance on the principle of the 'relief road'. The first has produced the worst of both worlds, neither safety nor comfort for pedestrians, nor convenience for traffic. Environmental sights should have been set much higher. It is, for example, interesting now to visit Exeter, where a comparison can be made of the new pedestrian shopping street (Princesshay) aligned on the Cathedral, and the widened High Street with the old mixture of pedestrians and traffic. In the former, something of permanent value has been created, foolproof against the worst that traffic can do, but the latter is a 'standard street' with neither real comfort nor convenience. It is not specifications of layout and design that are wanted so much as performance standards—pedestrians, for example, should be safe: that is a concept to be aimed at everywhere, but it can be achieved with a great variety of layouts.

390. As to the principle of the 'relief road', this, embodied in a proliferation of proposals for ring roads in towns all over the country, was an intuitive concept rooted neither in understanding of the realities of traffic generation and flow, nor in any quantitative idea of 'relief'. We by no means exclude the possibility that the appropriate network pattern for some town, when properly worked out, might take a form which could be described geometrically as a ring, but (as mentioned in Chapter II) it does not follow that a ring is a suitable prototype for every town. Many of the post-war plans demonstrate the peculiar difficulties of the *inner* ring road, namely its rigid encompassment of the centre, the severance of the central area from the rest of the town, the frequency of major intersections on a comparatively short length of road, the encouragement of heavy traffic along old-type radial roads, and the problems of constructing it through densely developed property.

217 The Barbican redevelopment in the City of London. Still under construction, but the photograph shows clearly the beginning of the upper level pedestrian system.

218 Exeter. The High Street as reconstructed after war-damage to standard dual carriageway form.

219 Exeter. The new pedestrian shopping street (Princesshay), 'foolproof against the worst that traffic can do'.

391. As to 'relief', it seems to us that relief roads are often designated without safeguards to ensure that the general increase of traffic does not soon make conditions as bad as ever on the relieved road. This is a special danger when the relieved road has some innate attraction for traffic. This point is so important that we are tempted to quote the controversial case of the High Street at Oxford as an example. In this case a relief road has been planned on an alignment which it is hoped will be sufficiently 'attractive to traffic' to give substantial relief to the High Street. The risk is that traffic will continue to use the High Street, and that only a measure of congestion in that street will force some traffic onto the relief road. As we have previously suggested, our approach would be to assess the 'environmental capacity' of the High Street, and then to consider what steps would be needed to reduce traffic to that level, and to hold it there permanently. Such steps would almost certainly include the compulsory direction of traffic, or most of it, onto the relief road. There would then be no particular need to choose an alignment for the relief road which would be competitive in journey-time with the old road, it could be put anywhere suitable. In the conditions that are going to arise in the future, as vehicles multiply in numbers, we think this kind of strict discipline of vehicular movement is inevitable.

Coventry

392. However, to return to the bombed city reconstructions, we do not wish to imply that all the work has been abortive, so much as to suggest that could the work be started again it is most likely that it would take a different form. We think this would even apply to the one case we propose to discuss in more detail—Coventry—generally regarded as one of the most interesting reconstructions in Europe.

220 Coventry. The shopping arcade.

221 The upper and lower shopping precincts at Coventry. This is one of the most interesting reconstructions in Europe, designed not only for motor traffic but as a place '. . . where it would be a pleasure just to wander about and sit around'.

393. The outstanding feature of the rebuilding of the centre of Coventry is the very extensive shopping precinct reserved entirely for pedestrians. It is much more than an ordinary street merely closed to vehicles. It is rather a whole series of connected open spaces with fronting shops, full of variety and interest. Part of this precinct has shops at an upper level served by a balcony. Part is covered over, and elsewhere there is a good deal of protection from the weather without shutting it out altogether. There are flowers, trees, pools and sculpture. It was conceived like this from the start, a definite attempt to make a place where it would be a pleasure just to wander about and sit around. Yet it did not come easily by its present form and scale. The precinct as originally planned was quite small in area, with surface car parks and goods access to the rear, and much of the shopping was to be along conventional roads. Then gradually the magnitude of the potential growth of motor traffic was realised, opportunities

were seized (not without opposition) to change the plan and extend the precinct, and the insufficiency of space for parking was overcome by bringing the roof tops into use, with bridges from building to building. It is a tribute to the initial plan that it was flexible in this way, and it is perhaps the quite considerable element of expediency in the design that gives it the vitality it possesses. Nor does the process of adjustment seem to be at an end even yet, for the volume of traffic gyrating round Broadgate Square is manifestly unsatisfactory, wasteful of the potential public amenities of the square, and it cuts off the precinct from the Cathedral. We understand that a large extension of the precinct is now proposed.

394. The eventual manner in which this design will function for traffic purposes is shown in Figure 223. It will be seen that there is a rigid enclosure by an inner ring road into which run the nine major radial roads of the city. Inside this ring, and enclosing the central precinct, is an 'inner circulatory road' which will carry the central area bus service, and distribute commercial vehicles to the service entrances of buildings. Car parking is to be contrived almost entirely at roof-top level or in multi-storey garages, with a quite elaborate linkage at roof level to give access from one car park to another. Access to the parking system is to be primarily from the inner ring road, not from the inner circulatory road. As might be expected with an inner ring road so obviously aligned for use for cross-town journeys, the expected traffic volumes are considerable and will necessitate a high-powered road. It is expected that it will mainly take the form of an elevated road on the northern and eastern sides, and will incorporate a depressed section on the southern side. Despite these and the fact that the present plans indicate the simplest possible forms of intersection, it is difficult not to have misgivings about the circumferential severance of the city centre which will result.

395. We have asked ourselves two main questions about Coventry: how far does this central reconstruction enable the motor vehicle to be exploited ? and is it a prototype for the 'motorized city' ? It is not easy to get

222 Coventry. The system of roof-top parking. There is interconnection from building to building.

223 Coventry. The central area plan.

at the answer to the first question, but it may be noted that an eventual number of 7,500 parking spaces is to be provided for the centre. This is in relation to a population of 360,000, and may be compared with the figure of 20,100 spaces for a population of 524,000 which we estimated could be provided at Leeds with the scheme for the intermediate network. At a rough estimate this would accommodate 40% of the potential number of work journeys by car to the centre. A direct comparison cannot be taken very far, but it does suggest that in Coventry a smaller proportion of people are likely to be able to travel to the central area by individual car. Indeed the wording of the Coventry report puts it quite clearly '. . . the majority of people will still travel into the city by public transport. . . . It is important that adequate public transport facilities to and from and within the central area should be maintained. A reduced frequency or standard of service would cause a far higher proportion of people to travel into the city by car, thus adding to the traffic problems of the central area in its developed form'. Our own rough interpretation of the position is that, given the broad design of the central area as contemplated, it is unlikely that more than about 30% of the personal journeys made to the central area for all purposes can be envisaged as being made by individual private car. It is very unlikely, of course, that the position will ever arise when people will seek to make 100% of the journeys by private car, but even so it can be seen that in Coventry, in spite of a massive and virtually complete reconstruction of the central area, certainly to a more advanced form than in any other city in Britain, the result is still very far from being 'fully motorized' in the sense of the freedom to use private cars. It will not be a matter of *hoping* for the maintenance of public transport, as of the *absolute necessity* to keep it going. This for a city of 360,000 population.

396. As to the question of Coventry being a prototype, it can be said at once that it undoubtedly is, as regards the standard of the environmental concept on which it is based. Whether it is a prototype in the design sense is open to question. We are inclined to think, for all the originality of the design, that were it to be started afresh it would in all probability take a quite different form, and that this would permit a higher level of motor car usage.

The Development Plans

397. Under the Town and Country Planning Act 1947 (as now merged into the 1962 Act) all local planning authorities (that is to say county councils and county borough councils) are required to prepare *development plans* for their areas. These plans show the intended uses of all land for a period of twenty years ahead, and the programme for realisation. The plans have to be reviewed, and if necessary revised, every five years. When the plans have been approved by the Minister of Housing and Local Government there is a statutory obligation on the planning authority to control all new development in accordance with the provisions of the plan. This machinery provides a complete system both for making a plan and securing, albeit in a somewhat negative way, its implementation.

398. As far as towns are concerned, the development plans take the form of 'Town Maps', drawn to a scale of 6 inches to a mile, which are sufficient to show the land uses in some detail together with the locations of car parks and existing and proposed roads. There are in addition certain other procedures whereby larger scale plans are prepared for areas where redevelopment is imminent.

399. Taking the development plans for towns as a whole, we think it is fair to say that very few of them deal adequately with future problems of traffic and transport. If it were otherwise, of course, this Report would not have been needed. The main defect is the absence of a general philosophy securely based on sound objectives and scales of values. All too little quantitative analysis has been carried out, with the result that many proposals are based on intuition. In many instances the supposed needs of through traffic have been given priority over the needs of town traffic, with

the result that proposals abound which, if executed, would be fatally damaging to local environments. There has been virtually no consideration of the problems of transport as a whole—railways, for example, have been consistently regarded as undertakings quite removed from the sphere of statutory town planning. Finally there has been the blighting effect of a sense of hopelessness as far as capital investment has been concerned. There is no incentive to produce creative plans if no hope can ever be seen of their implementation.

400. It is, in fact, when the *programming* of the proposals in the development plans is examined and compared with the expected rate of increase in the number of vehicles, that the real shock comes. There is no semblance of agreement between the two. Proposals that could be amply justified to deal with even today's traffic are frequently relegated to the long distant future. This is a fault in social priorities, and not the fault of those who make the plans. Society, it would seem, will need to realise that it cannot go on investing *ad libitum* in motor vehicles without concurrently investing equivalent sums in the physical accommodation for the vehicles.

401. In spite of these difficulties, the planning system based on development plans is clearly an instrument of enormous social value, indeed indispensable. Our suggestion is that it should be strengthened, by ensuring that traffic and transport are fully integrated into the planning process.

224 Cologne. The Hohestrasse in its reconstructed form. One of the main shopping streets of the city, it is closed to vehicles during normal hours.

225 An interesting feature of German reconstruction is the use of escalators in the open air. This example from Dusseldorf gives access to a pedestrian subway under a busy road.

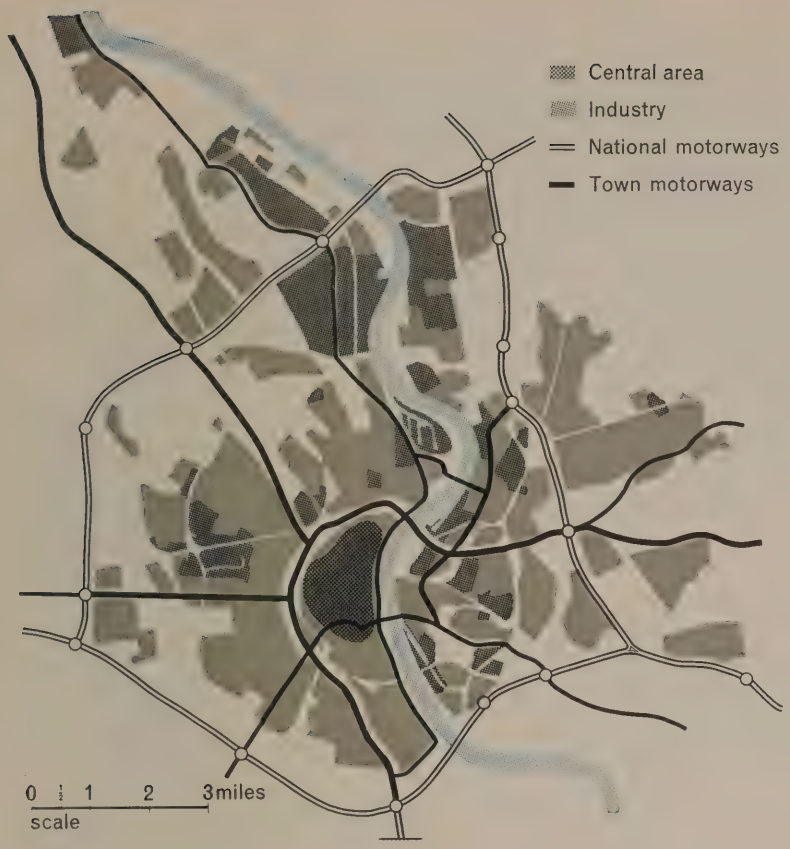
Europe

West Germany

402. The war-damage in many German cities was far greater in scale than in this country, so it is interesting to see what use has been made of the comparatively greater opportunities. It is a mixed story, as it is with our own bombed cities, and it can be said that nothing radically new or revolutionary has emerged in the course of reconstruction.

403. One of the most important features of the work has been the widespread acceptance of pedestrian shopping streets, even for the *main* shopping streets of the large cities. This is not by any means exclusive to the bombed cities—many which suffered no serious damage are now finding it desirable to close their main streets to traffic during shopping hours.

404. At Cologne, the main shopping street (*Hohestrasse*), wholly demolished during the war, has been rebuilt on its old line as a narrow crooked street with a strong mediaeval character. During working hours, it is closed to wheeled traffic by the simple expedient of inserting posts in slots at either end. Servicing of the shops has to be done in the early morning or at night. It would be wrong to say that the street is a fake, it is based on one kind of shopping street that many people are known to like—a narrow, intimate, snug, varied, bustling street—but without the conflict of vehicles and pedestrians. Eventually, when the central area plan is completed, both the main shopping streets of this city of over ½ million inhabitants will be *wholly for pedestrian* use. The same environmental concept is being applied at Essen and Bremen, and in a number of other cities. Where it has not been applied in a major reconstruction, as at Hanover, the contrast is painfully obvious. This last city is interesting because an inner ring road has been built to quite high standards of performance, but many vehicular routes (including the main shopping streets) cross the ring, and these are filled with traffic to the great detriment of the environment. It does seem as though it is quite insufficient to try to 'relieve' roads of traffic by some kind of diversionary system. A positive idea must be formed of the amount of traffic tolerable in the road that it is desired to relieve, and a definite plan laid to reduce the traffic to that figure and to hold it there permanently.



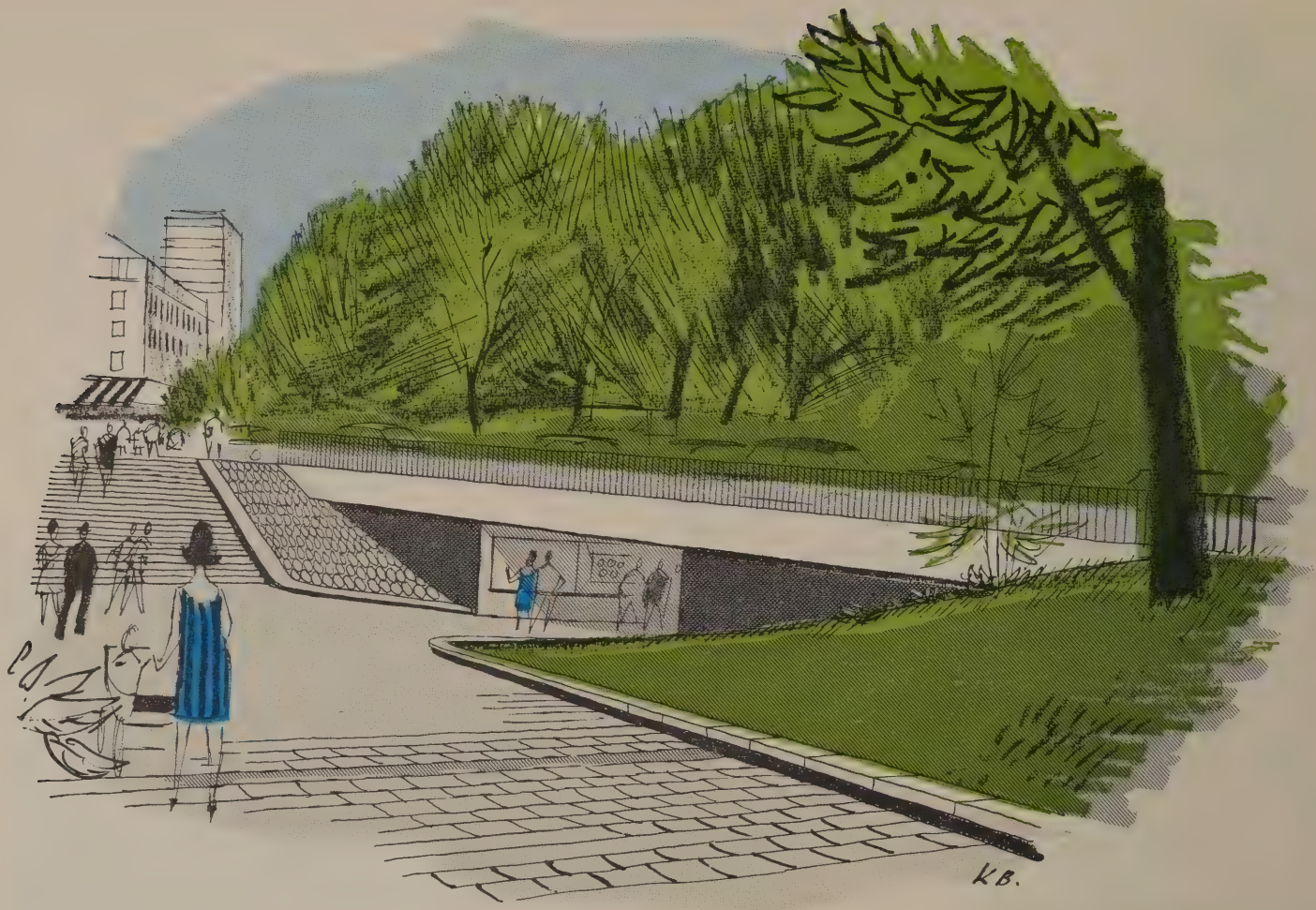
226 The network plan for Cologne (801,000 population) which provides for roads of motorway standards.

405. In much of the reconstruction in Germany, even though there had been almost complete obliteration of the buildings, there has been a marked sensitivity shown for the mediaeval street pattern, and it is this that is often re-emerging in the form of narrow streets for pedestrians only. The keynote of the reconstruction therefore is the horizontal separation of pedestrians and vehicles. A great deal of ingenuity is shown in the layouts for feeding in vehicles to service access points to the rear of or underneath buildings, and to ingeniously contrived and tightly planned parking places and garages. The way in which the past is thus brought into the present, even though the building fabric has been almost completely renewed, is impressive; it imparts a character to the redevelopment which is missing from much of our own stereotyped redevelopment based on a standard layout for a shopping street.

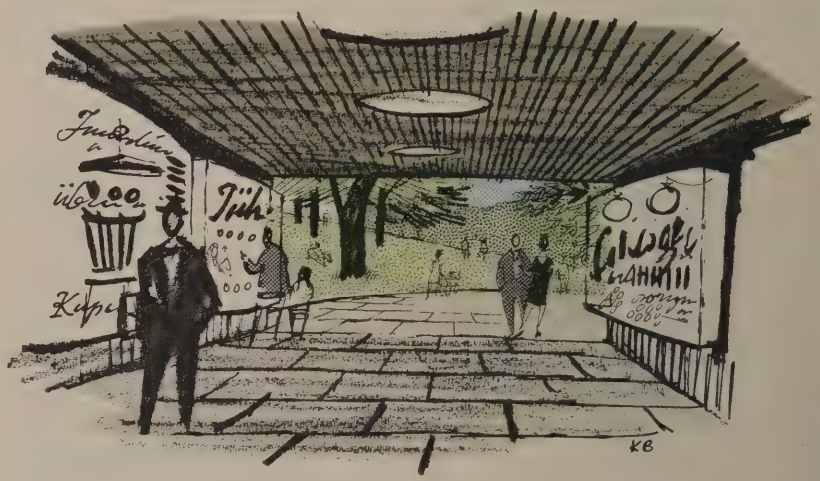
406. The respect shown for old street patterns means, of course, that little has been attempted in the way of two-level reconstructions which would have been the other alternative, and which would have resulted in greater capacities to accommodate traffic. Even so, the volumes of traffic which it is expected to be able to handle are impressive.

407. The concomitant of these high traffic volumes is that highway networks of considerable elaboration are being planned (Figure 226), and the great costs and difficulties of driving these through standing property are being accepted. But the inquiring visitor finds everywhere the same consistent policy that since there cannot be any question of accepting the full potential flood of centre-bound car commuters, the maintenance of mass transport is absolutely vital. An interesting consequence of this viewpoint is that most cities have not merely retained their tramway systems, but propose to elaborate them. In some cases new tracks are being laid down in the central reservations of new major roads; and in many towns there are plans for putting the tramways underground in central areas. This policy seems to have been most carefully thought out in the years after the war. It was adopted and pursued in the face of the knowledge that most other countries were planning to do away with trams.

227 The central area plan for Bremen which provides for an extensive pedestrian area, though with some admission of trams.



228, 229 West Germany. Impressions of a pedestrian underpass showing the great care which is devoted to the details and the landscaping. Note the pleasing proportions and lively appearance of the subway in the smaller sketch.



230 '... the superb quality of the design and landscaping of the new urban highways' (Dusseldorf).

408. The German scene cannot be left without reference to the superb quality of the design and landscaping of the new urban highways. There is a long tradition behind this, of course, starting with the pre-war 'auto-bahnen' which achieved a standard of design that opened the eye of many a visitor to possibilities he had not thought of in connection with a utility such as a road. In the urban work it is the attention to detail that is so impressive; there is nothing skimped or sloppy or unfinished; it is all done with a zest and a desire for perfection, and one feels that not only have the designers wanted it this way but they have known that the public will appreciate it too, and will be resentful if they do not get it.

Stockholm

409. It would require a long account to do justice to post-war planning and achievement in Stockholm. From the point of view of our present study we think the most significant point is that in this city, with a metropolitan population of one million, the post-war expansion has been based primarily on a new underground railway system, even though the country has the highest car ownership ratio in Europe. It seems to have been clearly understood, as early as 1941, that the bulk of the passenger traffic between home and work would have to be carried by public transport if wholesale and impossibly costly reconstruction of the city centre was to be avoided. It is very significant that a city of this size should have found it possible to finance the construction of an underground system, and to reach the bold conclusion that in the general public interest it should be a subsidised undertaking (Figure 231).

410. Perhaps of equal significance, however, is the elaborate highway network (Figure 232) that is also considered necessary, much of it to motorway standards, in spite of the policy that the main commuter flows to the centre should be dealt with by means of the underground railway system. No less than 45,000 parking spaces in special garages are still required in the Inner Town, and these in addition to parking places just outside the Inner Town linked to the motorway approaches. The lesson seems to be that in a big city, if the main tidal flows of car commuters can be avoided, then the residual motor traffic problem can be handled, *but it is still of formidable dimensions.*

411. In the centre of Stockholm much interesting redevelopment is being undertaken over large areas, either in the form of pedestrian streets or in multi-level arrangements. A group of five tall office blocks, for example, stands on a 20 ft. podium which is used as a terrace for pedestrians, with pedestrian shopping streets at ground level, and three levels below ground for servicing and parking. Many problems remain however before the motor vehicle can be said to be completely under control, and it can be argued that the new road system is having an undesirably disruptive effect on the waterfront. But a clear impression is obtained that there is real

231 Stockholm. The new railway system upon which the suburban expansion has been primarily based.

232 Stockholm. The elaborate highway network proposed for the central part of the city.

233 Stockholm. The multi-level reconstruction in the centre.

co-ordination of all kinds of transport with town planning and redevelopment, and that the City's bold policy of wholesale land acquisition since the beginning of the century has helped to make this possible.

Venice

412. It may appear to be taking liberties with the title of this chapter to include Venice as an example of current practice. But it is a working city and one of the very few in the world which, on the face of it, manages without the motor vehicle. So we decided to examine it to see what lessons could be learned.

413. Venice is a city of about 140,000 people on a group of islands in the Laguna Veneta. The city is connected by a causeway carrying both road and rail to the mainland at Maestre where there is a sizeable industrialised hinterland, where many residents of Venice find employment. So it is not absolutely true to say that Venice is a self-contained community not dependent on motor vehicles. Supplies, visitors and commuters arrive at and leave the city by road and rail. Nevertheless both road and rail are strictly confined to terminals at the north western fringe of the islands, and all the distribution to and from these terminals, and all the busy life of the city (bigger than Huddersfield, and with one of the largest tourist trades in the world), is carried on without *wheeled* motor vehicles. It is certainly not done without motor vehicles, because a great deal of the movement and transport is now contrived by *motor boats* on the canals.

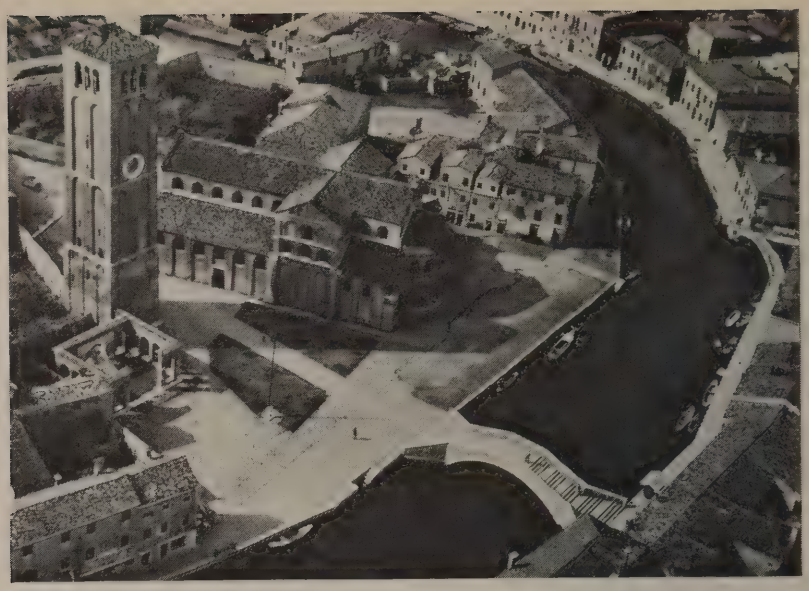
414. Venice proves in fact to be an extraordinarily interesting example of a network and environmental area system, rendered crystal clear because

the distributory network consists of canals instead of roads. The primary distributor is the Grand Canal—a major highway, two miles long and varying in width from 120 to 230 feet. The shallow depth of water and the restricted headroom below the bridges place a limitation on the type of vehicle, and speeds are officially restricted to just over 5 m.p.h. Water bus services operate on the Grand Canal. The ample width and the low volume and speed of traffic make it possible to mix the traffic functions, and the distributor is used both for movement and for direct access to some premises. The Grand Canal gives access to a further 28 miles of waterways which can be described as *district distributors* (usable by water buses) dividing the city into some 14 areas, and a more tortuous network of narrow *local distributors*.

415. Thus there is a clear system and hierarchy of distributors for vehicular traffic. In addition there is an entirely separate and extremely complex, continuously linked, system of pedestrian ways and alleys with a total length of about 90 miles. These are punctuated at intervals by piazzas around which each section of the city clusters. The piazzas are still the chief places of local assembly, worship, market and shopping. On this pathway network a splendid urban pedestrian environment is created. Continuity of the network is achieved, of course, only by an immense number of 'pedestrian overpasses' or, to put it simply, bridges over the canals. There are, however, only three bridges over the Grand Canal, and this makes for considerable inconvenience of pedestrian movement. Although the canals are remarkably penetrative throughout the clusters of buildings, enabling goods to be brought very close to destinations, there is also considerable use of the footways for final distribution by hand and by trolleys.

416. The communication system in Venice provides almost *complete* safety for pedestrians. There is no major nuisance from noise, but exhaust

234 Venice. The distributory system and the pedestrian ways.



235 Venetian townscape. There is complete separation between vehicular and pedestrian circulations.

fumes from boat engines can be unpleasant. There is no visual intrusion of vehicles in the pedestrian environment, and even on the distributors themselves the boats, unlike wheeled motor vehicles, seem to enhance rather than depreciate the scene. As to accessibility, most of the piazzas (or shopping centres) are served by water bus routes within distances comparable to those usually planned in this country, but for most people the walking distance from their homes to bus routes is greater than would be tolerated in a conventional layout served by motor vehicles. There must also be considerable difficulties in servicing buildings, furniture removals, burials, fire services, refuse removal and postal deliveries. Nevertheless the place undoubtedly functions, and reasonably well at that, without the strains and tensions set up by motor vehicles operating in conventional streets. But the picture drawn above is undoubtedly also influenced by the fact that private ownership of vehicles is low: conditions where every household made daily use of a mechanically propelled vehicle, even though it were a boat, would obviously be less desirable.

417. The important lesson of Venice is not that a large city can manage without wheeled motor vehicles—we are not suggesting the conversion of streets to canals—but that an interdependent system of vehicular and pedestrian ways can be contrived with *complete* physical separation between the two—so complete that they do not even seem to belong to the same order—and that it works. It is interesting that it was basically a Venetian arrangement which emerged in our comprehensive redevelopment study of the Tottenham Court Road area.

236 '. . . the vastness of the engineering works already undertaken' (San Francisco).

The United States

418. The absorbing interest of the United States is that it has gone more than twice as far with the motor vehicle as we have in this country. The ratio of vehicles per 1,000 persons is 410 compared with our own figure of 193. The total number of vehicles is 75 millions. These figures are reflected in the powerful impression a visitor receives of a mobile society. The sheer volumes of traffic, the enormous numbers of cars, the multiplicity of establishments catering for the needs of motor vehicles and their drivers and passengers, and the vastness of the engineering works already undertaken, all these make a deep and abiding impression. Yet further large increases in the numbers of vehicles are anticipated, partly because the national population is expected to double by the end of the century, and partly because there is still room for the further intensification of ownership. Surprising though it may seem, 26% of the families are still without

vehicles, and there are others who would like to have two, three or even four cars. Already in California joking references are sometimes made to the 'under-privileged two-car family'.

419. There are many differences between conditions in the United States and in this country which need to be understood if fair deductions are to be drawn. One of the most important is that there is no statutory land-use planning system comparable with the highly sophisticated system which has been evolved in this country. It is not true to say there is no planning, but it does appear to be the case that development largely takes place according to the play of the property market as influenced by the decisions of a very large number of local authorities (many quite small) exercising somewhat elementary zoning powers. The position varies from State to State, but it is said that Houston (Texas), which has grown up without the exercise of any zoning powers at all, is little different from many another American city.

420. In the absence of any different policy city development has taken the form of sprawl. The sprawl is truly enormous. Greater Philadelphia with a population of 5 millions is already 30 miles across. A journey across Baltimore and then Washington provides nearly 60 miles of unbroken urban development. Los Angeles is 80 miles long, and still growing. The root cause of sprawl is the tremendous population explosion by natural increase, though in California the effect is enhanced by westward migration. The sprawl takes the form that it does primarily because peripheral spread is the 'natural' easy way for a town to expand, and because there has been no effective planning machinery to direct expansion into any other form. But high car ownership, and the post-war mortgage system of

237 Californian sprawl, showing a suburban shopping centre with its surrounding car park.

the Federal Housing Authority, which has been tied very largely to detached free-standing houses, have powerfully influenced the suburban character of the sprawl.

421. These enormous spreads of development do not consist only of suburban houses. In the course of time all kinds of development have sprung up—in particular, scattered industry on a big scale, great suburban shopping centres, and major recreational centres such as Disneyland at Los Angeles. This spread and scatter of different activities has, as might be expected, generated cross-currents of movement of the greatest complexity. In many of these metropolitan areas, so great has been the scatter, that the dominating movements are no longer the flows into the centre of the city, but cross-flows between activities on the outer ring. This is especially the case where, as at Los Angeles, there has been a decline in the importance of the central or 'downtown' area.

Los Angeles

422. Initially sprawl starts as a groping for more space for living and for movement and with the belief that, with cars, distance does not really matter—but in the end it produces ever-worsening problems of transportation. The sequence of events is clearly illustrated by Los Angeles which deserves special mention for its claim to have the highest car ownership rate in the world. This enormous conglomeration of development appears to have started as a wide scatter of individual settlements centred on the larger town of Los Angeles itself. In the early days there was an efficient electrified railway linking the settlements. The great expansion of population by immigration then started, and with the motor vehicle then on the scene it produced, as might be expected, a low density spread of development reaching outwards from the old centres. This spread is now roughly 80 miles long and 50 miles wide, but with immigration running at 600 persons per day, it is still expanding.

238 Los Angeles. The Harbor Freeway skirting the downtown area. The disintegration of the downtown area into open parking lots is clearly visible.

423. The electric railway did not long survive the competition of the car, and its end was assisted by the proliferation of level-crossings as development spread out. But eventually the motor vehicle itself began to run into difficulties. The conventional roads along which expansion had taken place became progressively more inadequate for a highly mobile community, and parking problems and congestion in the downtown centre of Los Angeles itself became acute. A 'natural' remedy then began to assert itself. The presence of big suburban populations fostered the growth of suburban shopping and business centres that became highly competitive with the downtown centre on account of the better parking and traffic facilities. The downtown centre suffered considerable loss of business in consequence, and this eventually manifested itself in a visible deterioration of the physical structure, as unprofitable buildings gave way to open parking lots when attempts were made to revive the attractiveness of the

centre to the car-owning public. At the same time, however, the construction of an elaborate network of quite new roads—*freeways* as they are called—was commenced with the object of facilitating travel over the length and breadth of the sprawl. This network is now about one-third finished (eventually it will provide a 4-mile grid over the whole area) and already it has greatly facilitated travel, particularly to the downtown area which is enclosed by four tangential roads. Much of the network has had to be built through standing property, and the expense and disturbance have been enormous. That is the position at the moment. It remains to be seen how far the downtown centre will revive itself, and what further development the freeways will themselves stimulate.

424. Los Angeles prides itself upon being the most motor-minded city on earth. Should it be regarded therefore as a prototype? This is a difficult question to answer. There are places in the Californian sprawl where the workers in the splendid new factories of the 'second industrial revolution' (as the electronic age has been called) live within easy reach of the sea, in houses built to standards far beyond anything we can yet aspire to. There are air-conditioned shopping centres accessible by car, schools, colleges and universities, and a wide range of recreations. If these conditions could be offered to people living in the hard-pressed circumstances of many of our industrial cities, it is difficult to believe they would not grasp them as little short of Utopia. Yet a big doubt remains, for it is impossible to look at Los Angeles as a whole without concluding that had it been the product of deliberate planning, with full powers of land use control, it would have developed quite differently. Almost certainly it would have been made more compact; and one main reason for this, very pertinent to the problem under discussion, is that dispersal taken beyond a certain point complicates the transport situation by positively generating the need for vehicular movement. What Los Angeles does demonstrate is that a big sprawl can function, after a fashion, on the basis of motor transport alone, provided the density of development is not excessive, provided there is only a 'weak' central area permitting the avoidance of the massive traffic flows that a 'strong' centre generates, and provided highway engineering works of the most formidable nature are undertaken. But there is nothing to suggest that we would gain by spreading our own cities out, or still further spreading the conurbations, in order to reproduce the conditions of Los Angeles. All the American experience of sprawl suggests that in our small country we would do well to have no more of it.

The freeways

425. Widely differing views are expressed even in the United States about the success of the freeways. Looking at the matter objectively it is difficult to escape the conclusion, granted the initial premise of the sprawled out community intent upon using motor vehicles (and indeed sprawled-out on

239 Chicago. A depressed freeway skirting the downtown area. Note the great scale of the construction, how the local roads flow over the freeway, and the frequency of the access ramps which are about as close as could reasonably be contrived. The down-grade of the 'on' ramp assists acceleration, and the up-grade of the 'off' ramp helps deceleration.

240 The obtrusive freeway—the Central Freeway (double-decked) at San Francisco, with the City Hall beyond.

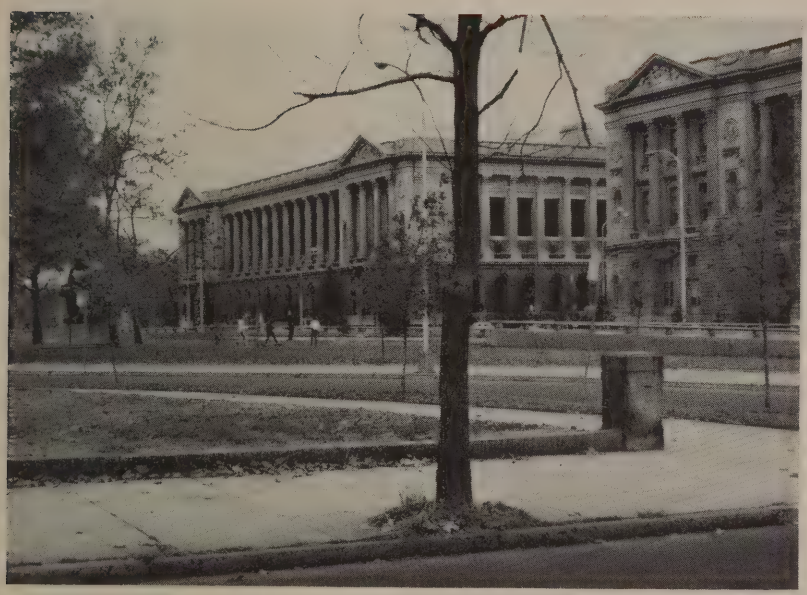
the basis and understanding that motor vehicles would be used) that the freeways are the inevitable, logical result. People declaim against the great destruction of property which the freeways have involved, but this seems to be the price that has to be paid for lack of planning in the first instance. Other people say that freeways 'never solve the problem' because they become congested as fast as they are built. This, however, does not always seem to be the fault of the freeways; it is often the fault of continuing sprawl (admittedly often sparked off by the construction of the freeway) which brings new loads of traffic, particularly of persons travelling to work by car. This, it would seem, must be the basic explanation of the situation on the Long Island Expressway, recently described as 'the longest parking lot in the world', and on the Shirley Highway leading west out of Washington, which now has to be pulled up from end to end and doubled in width in order to deal with the increased load.

426. Although criticism is heard in the United States of the freeways, it would be wrong to say that there has been a violent reaction against them. Very few people can be heard to say that the roads should never have been built, but it does seem to be becoming accepted that they are not the whole answer to urban transportation, and also that urban areas can stand only a certain amount of the extremely massive and space-taking engineering that is involved. In San Francisco, for example, two double-decker elevated freeway spurs partly encircling the downtown area have aroused strong criticism, and seem to have contributed to the recent decision to proceed with a £350 million project for an electric railway system. In Washington, too, the recent report of the National Capital Mass Transportation Authority recommends a curtailment of the freeway programme in favour of an electric subway. Even in Los Angeles there is talk of the need for a mass transport system.

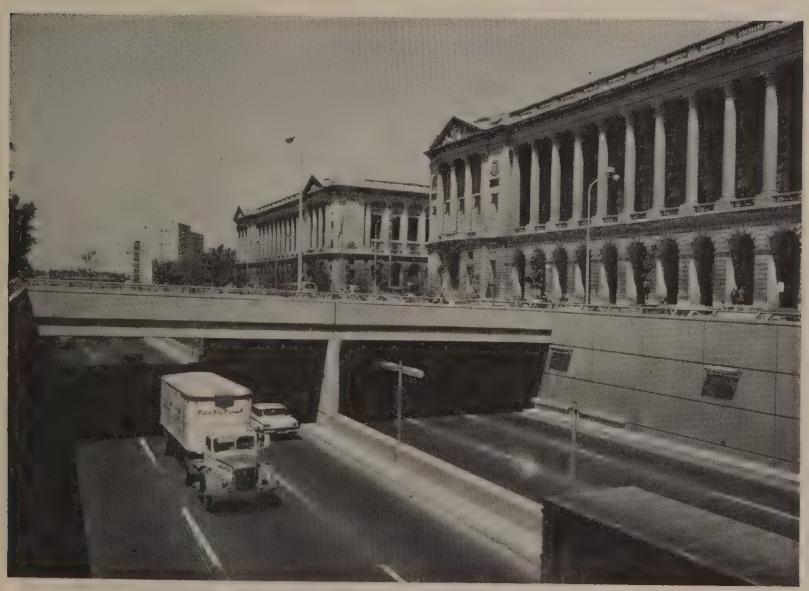
427. The great dilemma presented by the freeways is that though they are logical in principle they are extremely formidable structures to have to incorporate into cities. They are enormously wide, and whether depressed or elevated they tend to sever the areas through which they pass, they generate great noise (even when carrying cars only), and the ungainly interchanges present special difficulties. One single interchange planned for the inner loop at Boston will take about 100 acres of land; if such an intersection were put down in London it might well be situated in an area where people were living at a density of 100 persons per acre, so the displacement of population alone would be 10,000. There is no doubt that the depressed freeway is the best from the point of view of minimising severance, noise and visual intrusion—there is a particularly successful example in Philadelphia—but the costs are astronomical in view of the sewers and services which have to be deflected. It is tempting to think that *elevated* roads can be simple slender structures with clean lines, but by the time they have been provided with access ramps (without which they are little use in built-up areas) they tend to become wide, clumsy affairs.

241 '. . . formidable structures to have to incorporate into cities' (Boston, Mass.).

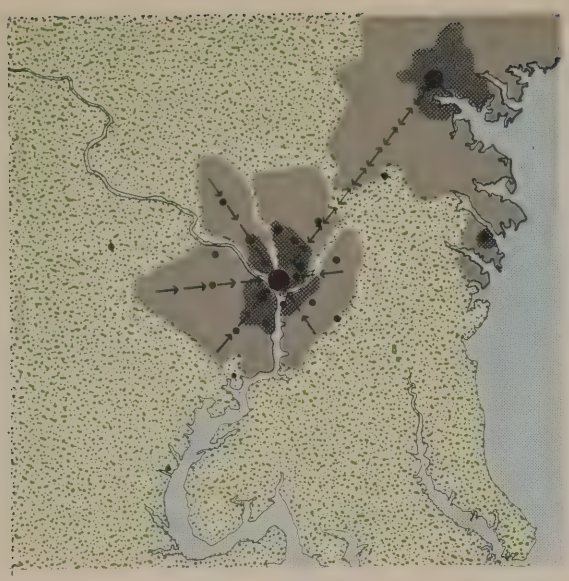
242 An interchange planned for the Inner Loop at Boston. It occupies about 100 acres. Compared with this, the interchanges shown in the examples worked out in Chapter III seem quite modest, yet they may be as much as British cities can stand of this space-taking engineering.



243 The unobtrusive freeway—between the camera and the buildings in the background is a 6-lane freeway. Fig. 244 shows how it is done (Philadelphia).



244 A close view of the Vine Street Expressway in Philadelphia as it runs in vertical cutting past public buildings. This is a highly successful example of the way in which a major road can be brought almost to the heart of a city without severe disruption.



245 Alternative possibilities for the future of Washington.

(1) Restriction to present size by a green belt

Consideration of Urban form

428. There have been two important reactions in America to the problems arising out of sprawl. The first is the great amount of thought that is being given to urban form, that is to say to the future shape of cities needed to deal more effectively with the transport problems of large urban areas. This is being done even though at present there is no effective planning machinery in sight that would enable any desired form to be implemented. One of the most interesting studies is that for Washington as it might be in the year 2000.* All the various possibilities are discussed—restriction to present size by a green belt, a series of new independent cities at a distance of about 70 miles, 'planned sprawl', a ring of satellite new towns, a joined-up ring of towns on a circumferential line of communication, 'peripheral communities', and the 'radial corridor plan' (Figure 245). It is the last of these that is recommended—six more or less symmetrical fingers would be pushed out for distances of 25–30 miles, each finger comprising a succession of semi-independent suburban communities strung along a radial communication corridor consisting of a first-class road and electric railway.

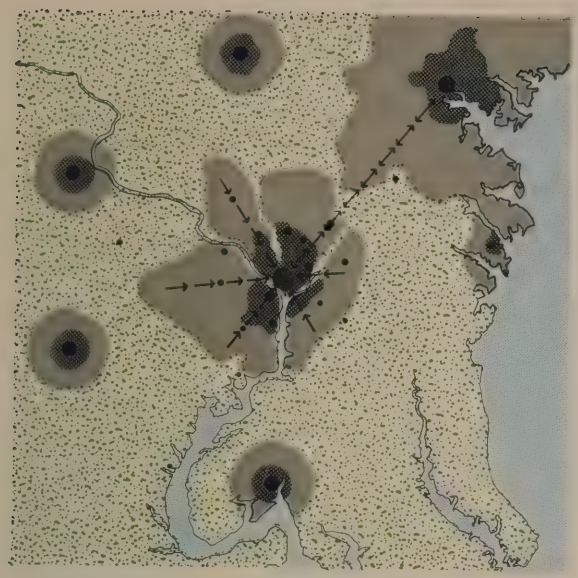
429. A British visitor, involved in these earnest discussions on urban form, tends at first to be perplexed and to find little relevance to the problems of his own country. Only when he realises the enormity of the population growth does he get the matter in perspective. In these suggestions for Washington, for example, it is not a matter of deciding what to do about a modest overspill from overcrowded areas, it is a matter of deciding the best way to deal with an expected expansion of population from two millions now to *five millions* by the year 2000. This, for one city, is indeed a mighty expansion. Yet it would be unwise to assume that our problems are any less difficult in proportion to the size of our country. As mentioned in the introduction to this Report, we shall have to find accommodation for more than 20 million extra people soon after the end of the century. If only one-third of these people attach themselves to London, or even settle in the south-east of England, as they may well seek to do, the planning problems will be formidable indeed.

The transportation studies

430. The second main reaction to the transport problems raised by sprawl has been the development of new and more intensive methods of studying them. To an outside observer the great 'transportation studies' in the metropolitan areas (the best-known are the Chicago Area Transportation Study, and the Penn-Jersey Study focused on Philadelphia) are the really striking features in American practice today. These studies are highly-organised, costly, continuing affairs, collecting and processing vast quantities of facts and figures with the help of elaborate computer techniques. They are notable in that they are applied over large areas, covering multitudes of small authorities in whose hands the zoning decisions lie. In a few words, the objectives of these studies are first to predict the forms that development will take as a result of the play of the property market and the likely decisions of the zoning authorities; then to forecast the consequences in terms of movement in the general sense; and finally to interpret the movement needs in terms of transport systems, that is to say to produce actual proposals for roads, railways, etc., to meet the movement needs. It is important to note that the studies are not, to use their own jargon, 'exclusively auto-oriented', indeed the fact that most of them are producing proposals for electric railways ('mass transit' to use the jargon again) to assist in handling heavy commuter-loads is the supremely significant result that is emerging. It appears to indicate a realisation that in certain conditions the mass use of individual cars either cannot be accommodated, or is a grossly inefficient way of moving large numbers of people.

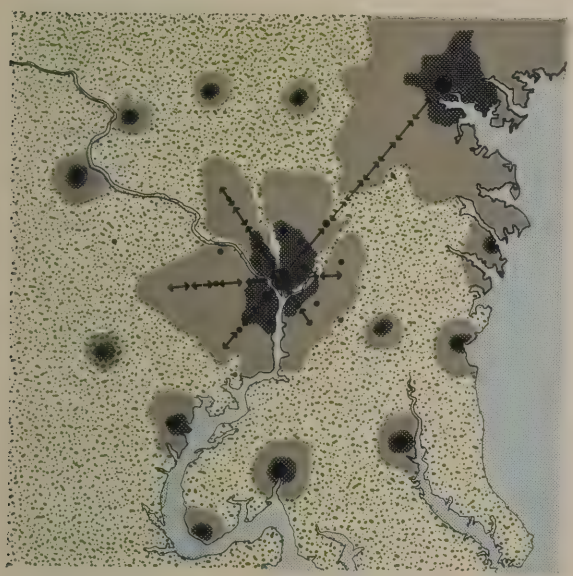
431. These studies bring to light a curious contrast between the political philosophies of this country and the United States. Here, under the stern

**The Nation's Capital. A Plan for the Year 2000.* National Capital Planning Commission and the National Capital Regional Planning Council, 1961.

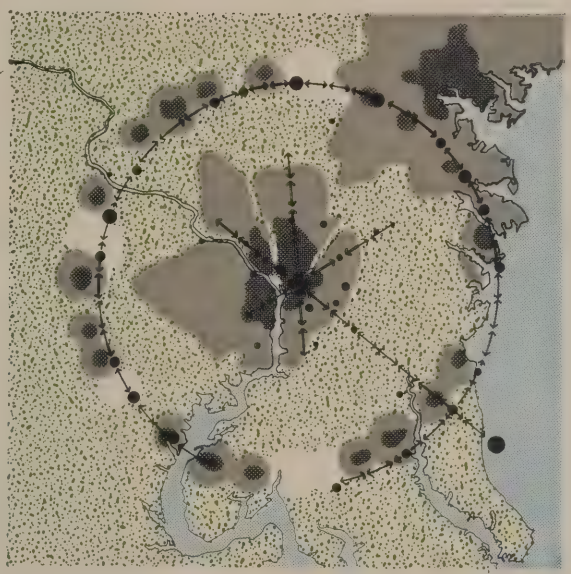


(2) Expansion by independent cities

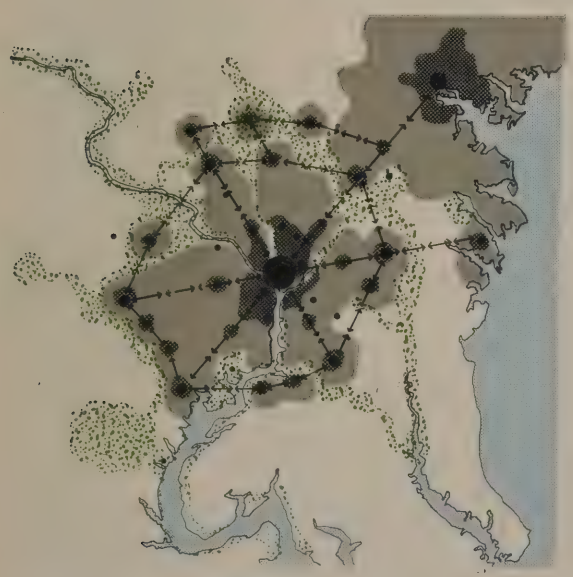
(3) Planned sprawl



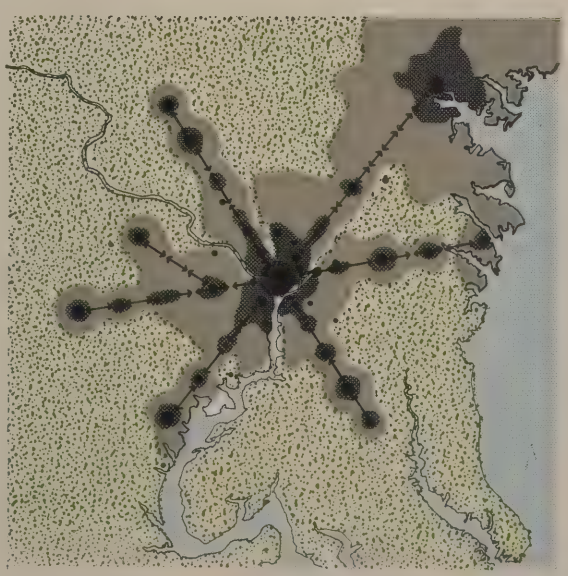
(4) Satellite new towns



(5) A circumferential ring of towns



(6) Peripheral communities



(7) The recommended plan for expansion based on radial corridors

discipline of a shortage of land, we have developed an elaborate and very onerous system of land use control, the need for which is the subject of a fair amount of agreement between the political parties. On the other hand we cling to ideas of freedom in transport and travel, believing people should have the right to go as they like. In the United States freedom in the use of land is jealously guarded, but, if the transportation studies are anything to judge by, there is a growing realisation that the close and planned co-ordination of various means of transport is essential to urban survival. Part of the explanation of this latter attitude is doubtless the much higher car ownership and the problems of sprawl, which have produced a crisis-point that we have not yet reached.

Central areas

432. Reference has already been made to the visible physical disintegration which has taken place in the downtown area of Los Angeles, rendering it a depressingly ugly place. The same seems to have happened in many other cities, though others, such as New York (Manhattan), San Francisco and Chicago, have had downtown areas of such intrinsic power and character that they have maintained their magnetism. This decay is indirectly another result of sprawl, it is certainly not a result (as often alleged) of the downtown areas having been 'carved up by freeways'. Even in Los Angeles the downtown area is *enclosed*, not cut up, by tangential freeways. In spite of the decay that has taken place there seems to be no idea of abandoning downtown areas. It is widely agreed that they still perform certain important functions, though it is recognised that these may have to be different in future. In Los Angeles the downtown area is seen as a place for Government and financial functions, cultural buildings

246 '... down town areas of such intrinsic power and character that they have retained their magnetism.' (Chicago. Bordering the far side of the river there is another wide highway *underneath* the road visible in the photograph).

of various kinds, head offices of business and industrial concerns, shops whose business is too specialised for them to flourish in suburban centres, and a shopping centre for the daytime business population. But it is recognised that many of the former shopping facilities have been transferred to the suburbs for good. This faith in the future of downtown areas is interesting, and relevant to our own position.

433. In some cities, vigorous efforts are being made to revitalise downtown areas. Some of this work savours of 'projectitis' (to use another American term), that is to say it takes the form of a single building project which, though it may be very large, is not discernibly part of a real attempt to redevelop the whole downtown area. The 'Mid Town Plaza' at Rochester in New York State appears to be in this category. This is a single very complex structure consisting of a large covered-in, air-conditioned shopping centre with 65 separate shops, three floors of parking below, and a 13-storey office block on top with a 4-storey hotel on the top again. It is an interesting example of multi-level planning, but whether, by concentrating so much into a single high building, it has helped to prime the redevelopment of the remainder of the downtown area remains to be seen.

434. In the centre of Philadelphia, on the other hand, a large scale redevelopment of great significance is taking place. It is a remarkable example of what can be done in the absence of anything resembling the town planning powers that we possess, but with a compensating readiness of owners and developers to accept and work towards an imaginative project. Much of the progress has been attributed to the fact that at the start the designers produced a three-dimensional architectural image of the centre of Philadelphia as it might be, and by keeping it constantly in view they so fired the enthusiasm of the public and developers that a general determination to have it was engendered.

435. The great interest of the Philadelphia redevelopment is that it is an advanced example of what has already been termed traffic architecture in this Report. It is not a matter of streets and buildings, but of a great comprehensively-designed multi-level complex of accommodation and access arrangements (Figure 60). But even with this elaborate scheme, the designers have disclosed that questions of space, environment, and practical design, put a limit to the amount of motor traffic that can be accommodated, and this in turn has led to important conclusions about the need to improve public transport.

The lesser impact of traffic

436. One curious thing a visitor notices in the United States is that, in spite of the great number of vehicles, the adverse effects are not everywhere as severe as they are in towns in this country. This is not to say that everything is perfect—Fifth Avenue, in New York, for all its wonderful shops, is a bedlam of noise, and heavy with fumes—but in some way there is not the same grinding confusion. There are several reasons for this. The most important is the gridiron street plan which is almost universal except in the newer residential suburbs. This, on the scale on which it has been applied in America, produces very dull, monotonous street blocks, and streets which go away into the distance with no apparent termination, but it undoubtedly encourages an even spread of traffic all over the grid, and the impact at any particular place is reduced as a consequence. It enables very extensive one-way systems to be used on the simple principle of alternate streets of the grid being one-way in opposite directions. It has the advantage that if there is a downtown business area in the middle of the grid, then there are numerous alternative by-pass or filter-through routes available in all four directions, and it makes it easy to devise special truck routes to keep traffic out of busy areas. Many of the streets too are wide, which reduces the impact of traffic. The gridiron plan thus seems an easier system to deal with than the typical European spider's web where the traffic is all funnelled down the radials into the centre, with great confusion resulting. Boston has just such a plan, and its traffic is noticeably far more confused than in other cities.

437. Other factors are the almost complete absence of motor cycles, and the very small proportion of sports cars, with all the noise they produce; the silence of the big powerful cars which most Americans favour; and the maturity of the standard of driving. This last, perhaps significantly, is most noticeable in Los Angeles. The drivers do not seem to be in a desperate hurry, they seem content to glide along in their big cars in an orderly way, and their regard for pedestrians is generally exemplary. This discipline must be partly the result of a longer tradition of driving than most countries possess, but it may also stem from the rigid speed limits on all roads, including the most modern freeways. It is significant that the country which has gone furthest with the motor car, and furthest with the construction of special roads to accommodate it, should have found it necessary to restrict speed to half the speed the motor car can now easily be made to sustain. The highest limit in California, is 65 m.p.h. At a stroke, one of the attractions of the motor (one of the main selling points in other countries) has been removed.

438. Last but not least in the reduction of the impact of the motor vehicle must be the freeways themselves in canalising many movements. But it should not be thought that all longer urban movements take place on freeways—a great amount of traffic is still carried on bad roads, bad in the engineering sense, and bad in the town planning sense. Even so, although the accidents reach the horrific figure of 38,000 fatalities a year, they are, in relation to the vast number of vehicles, considerably less than in Britain and the other major European countries.

Conclusions

439. It is difficult to summarise in a few words the lessons for us of American experience. There is certainly no ready-made 'answer' to urban traffic to be had for the asking. On the other hand the many dire warnings against 'repeating all the American mistakes' often seem unfair and ill-informed. Invariably these warnings are associated with the alleged destruction of cities by freeways, but this is not what has happened. The run-down of central areas ante-dates the freeways, and appears to be a by-product of sprawl. The freeways are the logical attempt to lace sprawl together and to bring life back to the central areas. They have not in general carved up downtown areas. The mistakes, if there have been any, would seem to have lain first in the belief that freeways could deal with all commuter movements, and secondly in the overwhelming of freeways as a result of further sprawl. The first mistake has been realised; the second, in conditions of population explosion, poses a severe problem. But the logic of freeways in conditions of sprawl seems unassailable. We have our sprawls too, and in such a huge one as London, for example, the case for a high-capacity network seems unanswerable.

440. There are other lessons too. There is no brilliant new physical environment for living with the motor vehicle apparent as yet, indeed one cannot but stand aghast at the great extent of the ugly and often sordid surroundings associated directly or indirectly with the motor vehicle, but there are many beginnings in sight. There are, for example, many suburban centres offering shopping conditions of a new kind, more efficient and pleasanter than anything in many capital cities, and with all the advantages of a car to hand. Another lesson of a different kind is to be found in the striking development of the scientific study of urban movement and its relationship to development. This we seem bound to follow, and if we could amalgamate this approach with our highly advanced planning system (in the sense that facility of movement becomes a *prime factor* influencing the planning of development) then we should achieve a major advance. Comprehensive redevelopment schemes, which are interesting examples of traffic architecture, are getting under way. They are backed by few of the planning powers we possess, but there is compensation in the readiness of owners, developers, the authorities and the public to work together for the betterment of their cities. Again, if we could amalgamate enthusiasm of this kind with our advanced planning system, we should make another great advance.

Chapter V: General conclusions

A beneficial invention

441. We conclude that the motor vehicle (or some equivalent machine) is a beneficial invention with an assured future, largely on account of the great advantages it offers for door-to-door travel and transport. There is an enormous potential demand for its services, and we think a constructive approach to the problem of accommodating it in towns and cities is both required and justified.

A two-fold problem

442. The best use is not being made of the motor vehicle in urban areas at present because of grossly inefficient circulations and the adverse effects of traffic on human life and surroundings. The first is costing the community great sums annually, the second is building up to a major social problem with a deeply tragic aspect. Unless something is done the position is bound to get steadily worse as the number of vehicles increases. But there is no simple 'solution'. The trouble is that the motor vehicle has put our urban arrangements based on streets completely out of date, it really demands quite different arrangements of buildings and access ways. The usage of vehicles in towns could be curtailed deliberately in order to avoid these problems, but the only justification for doing so would be the sheer difficulty of designing the necessary alterations to towns and the expense of carrying them out.

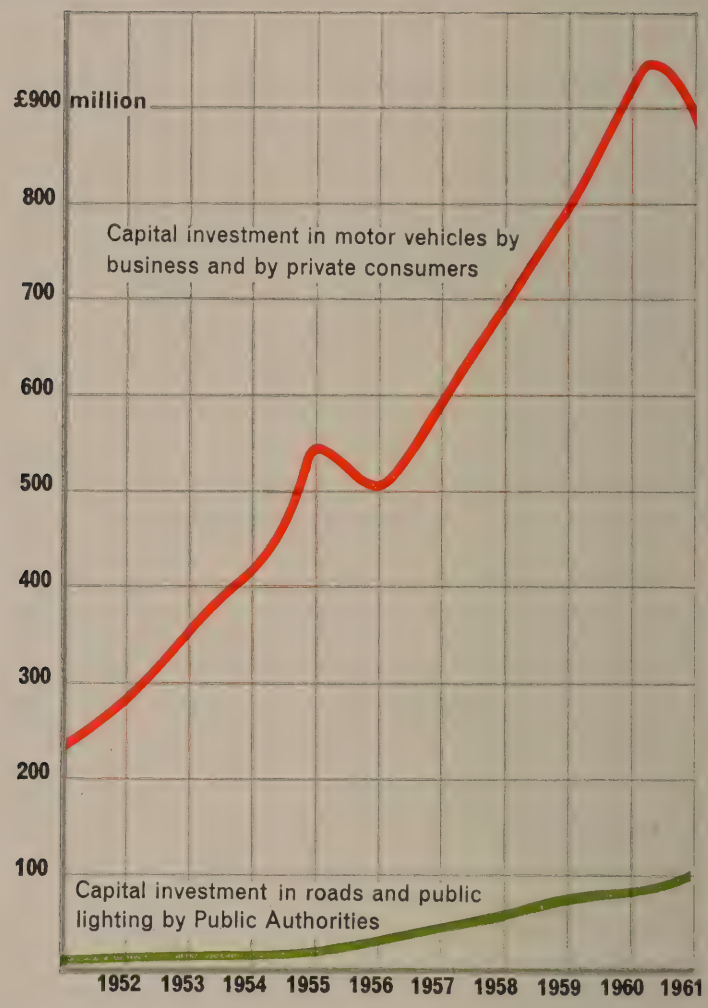
The basic principle

443. To accommodate large numbers of motor vehicles in towns and cities is bound to involve substantial physical changes. In broad principle these changes comprise the canalisation of longer movements onto properly designed networks serving areas within which, by appropriate measures, environments suitable for a civilised urban life can be developed. We make no claim to have penetrated all the complexities of this concept. A great deal more work is required to develop the quantitative side. But, in spite of the crudeness of our methods and assumptions, we think we have demonstrated that the concept, and indeed the whole subject of traffic in towns, is capable of being put on a rational and quantitative basis. Guesswork and intuition can be largely eliminated; given the necessary information, many aspects are precisely calculable; and there is scope for the development of techniques which will greatly ease the burden of decision between alternative courses of action.

A question of investment

444. The broad message of our report is that there are absolute limits to the amount of traffic that can be accepted in towns, depending upon their size and density, but up to those limits, provided a civilised environment is to be retained or created, the level of vehicular accessibility a town can have depends on its readiness to accept and pay for the physical changes required. The choice is society's. But it will not be sensible, nor indeed for long be possible, for society to go on investing apparently unlimited sums in the purchase and running of motor vehicles without investing equivalent sums in the proper accommodation of the traffic that results. It is true that

there are many other claims on material resources, but it is a weak argument to say the needs of traffic cannot be met, seeing that it is a problem we are continuously creating by our extreme readiness to invest in motor vehicles. There seems to be an issue here which society must face, for at present the two investments are getting further and further apart (Figure 247). All the indications are that to deal adequately with traffic in towns will require works and expenditure on a scale not yet contemplated.



247 Comparison of capital investment in vehicles by consumers and in roads by public authorities. (From *National Income and Expenditure* 1962, H.M.S.O.).

Traffic and development plans

445. Our studies suggest that very few of the statutory development plans really face up to the future problems of traffic and transport. Most of them seem to have been stultified by a feeling of hopelessness that funds would ever be available on anything like the scale required. Many contain proposals of a palliative nature which, if persisted in, can do irreparable harm and prejudice more constructive measures. We think the plans need re-examining, with a more optimistic view on the financial side, with the objectives and values clearly stated, and above all with a determined effort to get them onto a sound quantitative basis.

Static or expanding towns

446. Our studies have revolved around a somewhat static concept of the size of towns. In other words we have considered the cases of towns of a *given* future size, though including, of course, a period of expansion up to that size. We could have dealt with very much larger *planned* expansions. But we have not considered the problems of towns in a state of *continuous* expansion. It may well be, having regard to the considerable increase of population that is expected, that there is a field here for further investigation. Our studies certainly suggest that a plan for a primary network evaluated on the lines we have suggested—purpose-designed, that is to say, for a specific disposition of land uses and activities—would be thrown

seriously out of gear if continued growth of the town led to a completely different disposition of land uses. A plan for continuous expansion would have to be based quite differently—probably on some concept of transport corridors, with lateral development. As suggested in Chapter I, the time may come when new ideas on urban form suddenly crystallise, but meanwhile we are inclined to think that the 'static size' concept, involving deliberate decisions as to the future sizes of towns, accords with the realities of the situation in this small country. In this respect we have accepted, and have worked within the present broad policy of the statutory development plans.

Rearrangement of land uses

447. The techniques we have outlined would enable the effects and advantages to be assessed and judged of the rearrangement, in alternative ways, of the land uses and activities in a town. The effects of such rearrangement would be likely to be very slow in being felt, and in many instances, though valuable in themselves, would be no more than marginal to the main problems of movement. Nevertheless, as suggested in para. 99, it is an aspect of planning policy that should always be considered, and it could play an important part in suitable cases.

Planned co-ordination of transport

448. If, as we have concluded, it is impossible, except in the smaller towns, to provide for all movements to be made in individual motor vehicles, then obviously some degree of reliance upon mass transport is unavoidable. If movements have to be contrived by more than one means of transport, then clearly some planned co-ordination between transport systems is necessary. This applies particularly to the work journeys in concentrated centres.

Transportation plans

449. We think this co-ordination could best be achieved, in the initial stages at any rate, through the medium of the statutory development plans. Our suggestion is that the development plans for large urban areas should be supplemented by 'transportation plans' which would be part of the statutory submission. We are not in a position to specify the content of these in detail, but we would say broadly that they should assess the main movement needs that are likely to arise in the future, and indicate how these needs are to be shared by the means of transport available, including the private car. These plans should deal with the movement of goods as well as people. The mere act of preparing such plans would enforce the much needed integration of land use planning and traffic and transportation planning.

450. The phrase 'in the future', as used in the preceding paragraph, should be taken to cover the period up to the end of the century or a little beyond, this being the period in which the great bulk of the development of motor traffic is likely to take place. We realise that this is an extension of the normal 20-year period of the development plans, but we think this latter period is insufficient for problems of roads, traffic and transportation. Major road works are so costly, and so difficult to alter once they have been executed, that it seems essential to try to visualise the long term requirements.

451. We think it will be necessary for transportation plans to be based on a conscious decision regarding the extent to which the demand for the optional use of cars can be met. The plans should contain measures to influence the demand so that it matches the provision that can be made. There is very little experience available at the present time of the best methods for influencing the demand, but in principle there appear to be four possibilities:

(i) A system of permits or licences could be used to control the entry of vehicles to certain defined zones. (This is a clumsy method administratively, and the awkward problem remains, seeing that in all cities *some* optional traffic can be admitted, of how to make the choice.)

(ii) A system of pricing the use of road space.* (One scheme which has been suggested relies upon the use of electronic apparatus. At all the points of entry into the defined zone an electronic detector linked to a central computer would be set into the road surface. Every vehicle would be fitted with its own electronic identity plate. The computer would note the entry and exit of every vehicle into and out of the zone, it would record the length of time stayed by each vehicle, it would price the stay according to the demand for road space prevailing at the time, and once a month (or as desired) would prepare the bills.)

(iii) Parking policy.

(iv) Subsidising public transport so that it offers considerable financial advantages over the use of cars.

Parking policy

452. Of these four methods (which could perhaps be used in combination) everything points to the immediate importance of parking policy. It appears absolutely essential that the public authority should retain complete control of:

(i) the amount of parking space that is provided,

(ii) its location, and

(iii) the charges that are levied,

and it should be prepared to use this control methodically as part of the implementation of the transportation plan. It would not, we think, be sufficient to say that 'economic charges' (i.e. charges related to the securing of a reasonable return from the capital cost of providing the parking space) should be levied for parking, we think it is necessary to levy whatever charges the circumstances demand.

453. We suggest that parking policy is best kept on a rational basis if it stems from the *principle* that it is the liability of the owner or driver of a stationary vehicle to dispose of it off the highway. Departure from this principle rapidly leads to anomalies and unfairnesses. From this it follows that parking on the highway, or any form of publicly subsidised parking, are in the nature of concessions which should be zealously safeguarded by the public authority.

454. The question of how much parking space should be provided in *new buildings* needs to be considered from two points of view, namely, liability and convenience of access and circulation. Consideration of liability leads to the conclusion that the developers or owners of a new building should provide sufficient space within the site to accommodate all the *essential* traffic generated by the building—that is to say space for vehicles loading and unloading goods, space for official cars and operational vans, and space for the cars of 'essential' callers. But a great doubt attaches to the equity of requiring the provision of space for the *optional* traffic generated by the building, especially space for car-commuters employed in the building. To put it shortly: why should an employer be obliged to provide parking space for all and sundry on his staff who may choose to drive to work by car primarily for their own convenience?

455. From the point of view of access and circulation, the first study for the Tottenham Court Road area showed that when complete redevelopment is undertaken it is possible, with a multi-level design, to distribute the parking space in a very convenient way underneath or close to the buildings. This is one of the great advantages of multi-level designs. In conditions of more piecemeal development, however, the insertion of considerable amounts of parking space into every new building not only complicates the design of the buildings, but is liable to create considerable problems of circulation, and to prejudice the chances of converting streets

* We were much interested, in this connection, in a paper sent to the Steering Group on *The Restraint of Traffic in Congested Areas*, by M. E. Beesley and G. J. Roth (April, 1962).

to pedestrian use. There is also the risk, as demonstrated in the fourth Tottenham Court Road study, that the application of arbitrary parking standards to new buildings may produce an accumulation of parking space which the network cannot deal with. In conditions of piecemeal redevelopment it would seem better to concentrate parking space for optional traffic, especially car commuters, in purpose-built garages strategically sited in relation to the network.

456. To summarise, we think present parking policies need re-examination to ensure that traffic difficulties are not being 'built in' by the provision of too much parking space in the wrong position, and that owners and developers are not being burdened with liabilities which are not really for them to carry. The second point is particularly relevant to propositions which require developers to pay commuted sums towards the provision of parking in some other place.

Public transport and private cars

457. In the long run the most potent factor in maintaining a 'ceiling' on private car traffic in busy areas is likely to be the provision of good, cheap public transport, coupled with the public's understanding of the position. This last is essential, and is indeed one of the reasons why we have endeavoured to write this Report in non-technical language for the general reader. But the attractions of private cars are very great, and there can be no denying the difficulties of providing public transport services so intrinsically *convenient* that they will attract optional car traffic off the roads in appreciable quantities. But, given a different financial policy, travel by public transport could be made *relatively cheap*, and this may prove to be the key to the problem in the long term.

Peak periods

458. Even if account is taken of the need to rely upon mass transport for the main movements of people in larger cities, our studies indicate that the use of private cars for journey to work, resulting in highly concentrated flows in the mornings and evenings, would remain as one of the main aspects of the traffic problem. If these peak flows are to be accommodated efficiently, it means that a road system has to be provided which is under-used outside the peak hours. It can be argued that this is an uneconomical course to take when there is the alternative that hours of work could be staggered, and the load spread more evenly over the day.

459. We think there is a risk here that a short-sighted view might be taken in order to avoid immediate decisions or expenditure, but which would be regretted later on. The choice facing society is between affording, for its own convenience, a road system of some elaboration, or staggering its hours of work all round the clock to its obvious inconvenience. If this country is to move forward with a steadily rising standard of living, then one main demand will be for normal hours of day-time work for as many people as possible, and society is likely to feel it can afford the various facilities, including transport, that will make this possible. Whilst some modest staggering of hours of work is clearly possible and desirable, we think, on a long term view, that the concentration of travel into peak periods must be accepted as a fact of life, and that transport systems must be designed to cope with it. There is the possibility, however, that a substantial reduction of working hours at some future time would enable a more acceptable staggering to take place during daylight hours. Some people would regard this as a remote possibility in view of the gregarious nature of society, but if it were to happen, then the effect in, for example, the case of the intermediate network we demonstrated for Leeds, would not be to render the network over-elaborate but to allow more optional traffic to use it. As to the possibility of the network being generally over-elaborate in conditions of increased leisure, it has to be asked what people are likely to do with their leisure—it is certain that many of them, in pursuit of various objectives, will wish to drive around town in cars, increasing rather than diminishing the demand for road space.

Factors affecting the amount of optional peak period traffic

460. Our studies showed that the amount of optional traffic that could be accommodated was, proportionately, greatest in the smallest town studied, while it was least for the London example. The Leeds study fell in between the two. The explanation for this apparently inverse relationship, is not, however, to be found strictly in terms of town size, so much as in three separate factors. These are the capacity of the primary distributory system, the density of development, and the duration of the peak period. This suggests that if, in any particular case, the proportion of optional traffic which can be accommodated is thought to be too low, there are three ways in which it could be increased:

(i) by improving the capacity of the distributory system, including balanced parking allocations,

(ii) by reducing the potential number of optional users through reduction of density (i.e. removing some of the activities right out of the area so that fewer people work within it), and

(iii) by extending the length of time of the peak period.

461. Method (i) above is likely to involve formidable constructional complications. Our studies show clearly the great scale upon which networks are required even to deal with quite moderate proportions of optional traffic. Method (ii) has to be undertaken on quite drastic a scale to achieve a big change in the proportion of optional traffic that could be accommodated. For example, in the Tottenham Court Road 'complete redevelopment' scheme, about two-thirds of the floor space would have to be put elsewhere to allow 100% of the optional traffic to enter the area. The floor area per acre of site would have to fall from 2·8 acres to about 1·0 acres. In the case of the Leeds study about half the floor area would have to be overspilled.

462. Method (iii) may be said to be equally unrewarding. In our Leeds study, for example, we assumed that the evening peak period would have a duration of about one and three-quarter hours. The average flow during the peak *hour*, the basis for design, is about 25% above the average for the peak period. On the network, the peak-hour flow would generally be about twice the average hourly flow from 6 a.m. to 10 p.m. Even if some way could be found to persuade people to stagger their times of leaving work-places over a period of, say, $2\frac{1}{2}$ hours, the proportion of the potential work-journeys by car that could be accommodated on the limited network would rise from 40% to only 55%. Employing the same principle, to accommodate the *whole* of the potential optional traffic, would require the times of leaving to be staggered over a total period of some $4\frac{1}{2}$ hours.

The scale of the primary roads

463. A striking result of our studies is the demonstration of the great scale of the primary networks and interchanges that are required. We do not think we have been guilty of any exaggeration here. The scale reflects a desire to face up realistically to the future growth of traffic, but it is also the result of the principle we have suggested for the canalisation of longer flows in order to produce relatively undisturbed areas where environmental qualities can be developed. Even so it has to be admitted that the scale is somewhat frightening, and it may be thought that what we have illustrated is about as much as British cities could possibly stand in the way of being dissected by major roads.

464. It would, of course, be a total disaster if roads were built on this scale without regard to the environment. But we think the approach to the problem which we have outlined in this Report provides a way of securing that the scale of the roadworks does not outstrip the needs of the environment. The general lesson is unavoidable—if the scale of road works and reconstruction seems frightening, then a lesser scale will suffice *provided there is less traffic.*

Aesthetic treatment of primary roads

465. An aspect of the problem which emerges from our studies as extremely important, but which we have not had the opportunity to study in detail, is the aesthetic design and landscaping of primary roads and interchanges. It is not only a matter of *locating* these roads with regard to broader considerations of environment, but of ensuring that they are intrinsically well designed. In this it is important to ensure that the designs take account of the manner in which the structures are viewed. The requirements of the 'driver's eye view' and the 'pedestrian's eye view' are quite different.

Historic towns

466. The study of Norwich indicates the kind of approach which we think must be adopted in the case of areas of historic or architectural interest. It is based on frank acceptance of the fact that, if major physical changes are out of the question, then there must be a reduction of accessibility, with the possibility of considerably more circuitous journeys for drivers. Once again this is a matter of securing the public's understanding of the position. There is a great deal at stake: it is not a question of retaining a few old buildings, but of conserving, in the face of the onslaught of motor traffic, a major part of the heritage of the English-speaking world, of which this country is the guardian.

Environmental management

467. Our studies show that urban areas are a long way behind coping satisfactorily even with *present* traffic volumes. Even if funds were allocated on an unprecedented scale, it would take a long time to catch up with the situation. The full logic of the ideas we have presented would entail the deliberate restraint of traffic until such time as urban areas were in proper shape to accommodate it. But as works were completed in various parts of the town, so the environmental capacity would be increased, and the 'traffic ceiling', as it might be called, could be progressively raised.

468. This is doubtless a counsel of perfection, but we think something of the desired result could be obtained by the development of the technique we have called 'environmental management'. What seems to be happening at the present time is that many traffic flows are being steadily augmented by the use of cars for optional journeys to work and to shopping. The result is increased congestion. The authorities, desperate for remedies, instigate traffic management schemes which 'spread the load' by diverting traffic over a wider network of roads. But this frequently introduces heavy traffic into streets which have an environmental function, with harmful results for the people living there. It seems to us a questionable ordering of social priorities that one group of people should find their established amenities ruined in order (in effect) to enable another group of people to use their cars for optional purposes.

469. Environmental management would comprise, essentially, the delimitation of potential environmental areas, the removal of extraneous traffic from such areas, and the re-organisation of the system for internal movements by vehicles and pedestrians. The process could not be carried very far without there being a continuously-linked network. But directly this was established, even if insufficient in capacity due to limited width or inadequate junctions, it could be used, and its lack of capacity would act as the general restraining valve. The effect of this would be to transfer congestion to the embryo network rather than to let it build up in places where people live and work. If there has to be 'restraint by congestion' (which we do not advocate as a desirable state of affairs, but which is likely to prevail in the interim stage) then the network seems to be the right place for it. To the extent that such congestion delayed seriously the flow of essential traffic it might not be acceptable, but the first remedy would be to curtail the optional traffic by some means in order to allow more space for the essential traffic.

Basis for an integrated policy

470. At the present time there seems to be a developing conflict between certain short term traffic measures and long term planning objectives. We suggest these might be overcome to some extent if these traffic measures were regarded as somewhat in the nature of 'development' as defined in the Town and Country Planning Act. It is an anomaly of the present planning system that a person who, say, finds that a petrol station or office block is likely to be built to the detriment of his enjoyment of his property, will in all probability get some chance to have his objection heard; but a person living in a quiet road can find it turned into a traffic route overnight by the mere erection of a signpost by the highway authority, and has no chance to register his views. If, however, traffic measures were regarded as *development* then they would have to be incorporated in the development plan and they would then be worked in with all the other proposals.

471. We are concerned here, of course, with those traffic measures which can have an appreciable effect on environment, not with relatively minor matters such as pedestrian crossings. We have not had the opportunity to explore all the intricacies and repercussions of this idea, but we see no reason, in principle, why a planning authority should not be able to think out ahead the various measures necessary over a period of years for the handling of traffic, and delineate them on a map which would be part of the statutory development plan. Once again the mere effort of preparing such a map would enforce the integration of traffic planning with land use planning, and would, we suggest, provide the basis for a smooth, continuous and fully integrated policy, without the discordances that are apparent at present.

Comprehensive redevelopment

472. We think our studies demonstrate that the ability to command the comprehensive development or redevelopment of large areas is extremely important to the successful handling of motor traffic. Conversely the piecemeal replacement of individual buildings in existing areas is likely to be very restrictive. Comprehensive development makes it possible, in particular, to apply the techniques of multi-level design, which not only yield much-needed extra space, but open the door to the creation of new environments of the most interesting and stimulating kind.

473. Comprehensive development presents many formidable problems of finance, administration and land ownership. Local authorities can undertake it, provided they own the land, either themselves or by letting the land off on building leases. But this is almost certain to necessitate the use of compulsory acquisition on a big scale, with vast financial outlay bringing no returns in the early stages. Private developers can undertake it provided they can overcome the difficulties presented by the multiplicity of ownership. These difficulties are acute. Moreover, as matters stand at present, private enterprise is, naturally enough, only interested in the profitable rebuilding of commercial and business centres, and finds little inducement to tackle the enormous 'twilight areas' of obsolescent 'by-law housing' of which there is so much in our towns.

474. It would be outside the scope of this study to enter into these questions of comprehensive development except perhaps to make three points:

(i) The scale upon which action is required is so great, especially if account is taken of the increase of the population which has to be accommodated in the next 40 years, that it seems doubtful whether existing agencies using present constructional methods can possibly cope with it.

(ii) If private developers are going to play a major part it would seem necessary to encourage them to have a greater sense of responsibility for the public weal than has been evident since the war. Means should be found to promote a greater readiness to co-operate with other developers; to pool and re-share interests, sometimes even to

forego the full commercial potential of a site; sometimes to postpone or advance rebuilding projects and, in the case of big projects, to offer substantial concessions to the public amenity. But it should also include the duties of patronage, to co-operate in experiments, to try new forms and to commission designers with vision.

(iii) But if private developers are to play an important role, the local authorities have an equal obligation to be ready with the broad 'framework designs', so that developers know the context in which to work and are not unduly delayed, and to ensure that projects, whether publicly or privately sponsored, are part of one coherent overall design.

Development control

475. We have dwelt for the most part on the broad principles for dealing with the problem of traffic in towns. But it is a problem that also requires unflagging attention to details. We stress in particular the need for vigilance in the handling of applications for planning consent for development, in order to ensure that new difficulties are not created, nor future prospects thwarted. This, of course, is the normal function of planning control, but in respect of motor traffic two points require special care: first, the cumulative effect of individual projects which, taken alone, appear to create no great additional traffic load; and second, the siting of establishments which cater directly for motor traffic. To give one example, a petrol filling station which gets itself securely rooted in a shopping street not only increases the traffic in the street, but may effectively prevent future conversion of the street to pedestrian use.

Grant systems

476. Our studies demonstrate the great importance in larger towns of town traffic as opposed to through traffic. This has a bearing on the present system of financial grants from central funds for the improvement of highways. There are four main points to be made. First, the present system has been based, ever since it was inaugurated in 1909, on the concept that central funds should be used only for the benefit of through traffic. Some doubt is thrown on this concept when it is realised that the major problem in towns is to deal with terminating traffic. Secondly, the present grants are rigidly tied to highway works, and to such minimum redevelopment outside the highway boundary as may be necessary to enable the job to be executed. Thus road works and the wider lateral redevelopment they necessitate tend to get out of phase. Thirdly, there is the danger that normal highway grants may operate to the severe detriment of environmental qualities, especially in small towns. Fourthly, as we have shown, comprehensive redevelopment is very important for dealing with traffic problems, but financial aid for this is administered completely separately from highway grants.

477. We think the present grant system, with its emphasis on through traffic, has almost certainly been responsible for clouding the issue as far as the real nature of urban traffic is concerned, and that for nearly half a century, by fostering the existence of powerful, but narrowly conceived highway departments in the local authorities, it has prevented the proper amalgamation of highway planning and land use planning. There is an important lesson to be learned from the United States which is pertinent to our own position if funds were to become available on a much bigger scale for urban road works. This concerns the dangers that arise when highway authorities, acting with a great degree of independence, are able to deploy enormous resources to one end only—that of speeding the flow of traffic.

478. We have no concrete proposal to make, but we suggest it would be worth exploring the possibilities of orienting a comprehensive grant system towards the kind of approach set out in Chapter II above. We mean by this that grants would be available for dealing with traffic problems, but the latter term would have a new definition encompassing accessibility *and*

environment. If suitable networks and environmental areas are to be established, it would seem that the grant system should operate in such a way that the plans which secure the best accessibility (using the term in a wide sense) and the best environment for the least cost ought to attract the most favourable rates of assistance. Such an approach would encourage the authority to strive for efficient, co-ordinated schemes, with a proper fusion of the town redevelopment and traffic planning processes.

Professional collaboration

479. One point which the description of our practical studies illustrates vividly is the close interlocking between questions of land use on the one hand, and transport and movement on the other. This applies all the way down from the widest questions of regional planning and the distribution of population and employment, to the detailed design of city centres. This is extremely important and points the need for the closest co-operation between everyone working in these fields. We think this applies to the internal organisation of central departments, and the whole range of local authorities. But most important of all is the need for a new synthesis of minds amongst those professionally engaged in these problems. A much improved concept of professional collaboration is needed, with greater emphasis on mixed-team working.

Further research required

480. Our studies do no more than disclose the first stage of a big subject. Basically it is the great social problem of the form and organisation of towns and cities that requires attention, and there is much to be done. With particular reference to the problems of transport and traffic the following are some main headings under which further research is required:

(i) *Urban Form*

The physical form of urban areas making for minimum or most efficient movement, with particular reference to size, density, distribution of land uses, and changing social habits. These are important questions in view of the great increase of the population that is expected.

(ii) *Movement*

The quantitative relationships between land uses, activities, and traffic generation. Methods of predicting movement demands for various dispositions of development. The allocation of demands between transport systems.

(iii) *Networks*

Theoretical network patterns. Questions of capacity. Methods of arriving at practical patterns. Problems of the staged construction of networks. Design and aesthetic problems of wide roads and big interchanges situated in urban areas.

(iv) *Environment*

Environmental standards. Environmental management as a technique.

(v) *Comprehensive Development*

(*a*) Problems of finance, organisation and execution,
(*b*) problems of design, scale, and traffic architecture,
(*c*) building and constructional techniques for large-scale operations.

(vi) *Cost benefit analysis*

Further study of the application of cost benefit analysis, in order to reveal where, in complex problems, the public advantage really lies. This would have a bearing on the development of new ideas for the issue of grants of financial assistance to local authorities.

(vii) *Movement Systems*

Continuing study of ways and means of moving people and goods around in urban areas. The problem of movement will always be such that there will be a place for new methods of proved efficiency and economy. There is no organisation working methodically in this field at present.

A sixth sense required

481. We have concluded that the motor vehicle, or something like it, is here to stay; that numbers may increase three or four times by the end of the century; and that half the total increase is likely to come within ten years. The studies indicate the kind and scale of measures required to meet the increases of traffic. But when traffic growth and the measures are compared, it is difficult to avoid the conclusion that, for a long period ahead, traffic will increase faster than we can hope to cope with it, even on the most optimistic assumptions of capital investment. It may even be thought that a desperate situation will arise. The further conclusion is unavoidable: that conditions as they are going to develop in this island in the next ten years or so, will demand an almost heroic act of self-discipline from the public. It is not only road safety that is involved, but everything to do with the sane and civilised use of motor vehicles. Motor manufacturers, parents and teachers will have major parts to play, but the main burden of responsibility will rest with drivers. If ever there was a need for a sixth sense, this appears to be the best example—a sense of 'motorised responsibility' appropriate to a society which is in process of acquiring mobility on a scale unknown to previous generations.

The creative opportunity

482. Our studies indicate that the main creative opportunities for dealing with motor traffic will come in conjunction with the enormous task of urban reconstruction and expansion which faces this country. The pressures that are now developing—the increase of the population, the reaction against overcrowding and obsolescence, the increase of motor vehicles, the demands for industrial productivity, the continued drift of population and employment to the south, the rapidly increasing demands for holiday facilities—these are such that, unless the greatest care is exercised, it will be easily within our ability to ruin this island by the end of the century. The greater part of it could easily degenerate into a wilderness of sprawled-out, uncoordinated development. On the other hand, given public understanding of the matters at stake, the smallness of the country could be an asset. Recreating the urban environment in a vigorous and lively way could do more than anything to make it the most exciting country in the world, with incalculable results for our welfare and prosperity.

Appendix I: The environmental capacity of streets

1. It was suggested in Chapter II (paras 129–132) that every street must have two capacities for traffic—a *crude capacity* related only to the movement and parking of vehicles, and an *environmental capacity* in which account is taken of the need to restrain the volume of traffic in order to maintain environmental standards. It was further suggested that although the street, as a form of layout, is basically unsuited for motor traffic, it is nevertheless bound to form the backbone of towns for a long period ahead, and therefore the estimation of environmental capacity must be very important in planning the future function of many streets. Whilst we have had no opportunity to study the matter in depth, we think it may be useful to describe our tentative approach because it indicates the direction in which further work is required, and because the cases we examined considerably influenced our approach to our subject. We also think it may be of value to venture some opinions, however provisional, of the acceptability or otherwise of some actual traffic flows in some actual cases, because at the present time there is practically no yardstick by which conditions can be judged.

2. The Appendix is in two parts. The first deals with residential access streets, and the second with non-residential access streets.

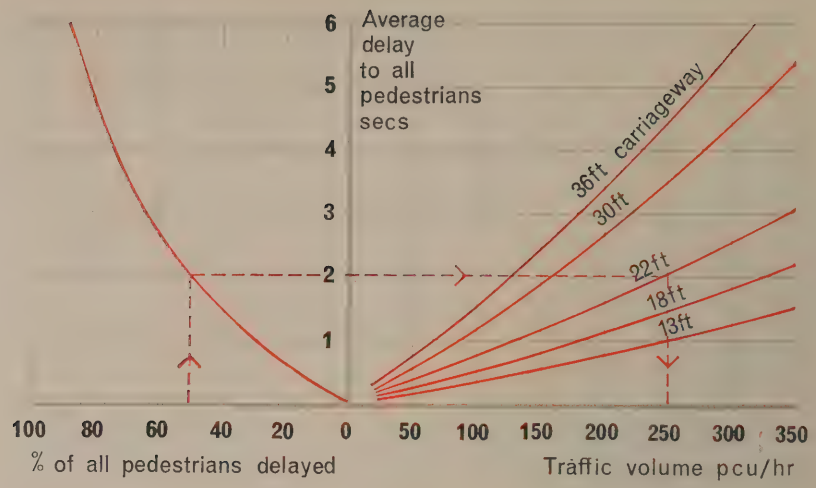
Residential access streets

3. Traffic in residential streets affects the environment in various ways—through noise, fumes, or vibration, for example—but perhaps the most crucial aspect is the danger that arises for people who wish to cross the street. Statistics show that 80% of all fatal and serious accidents to pedestrians are connected with the act of crossing the road. The possibility we have explored is that the environmental capacity of a street could be assessed, for practical purposes, by the ease with which the street can be crossed by pedestrians, and that if this crucial condition could be satisfied, then it is likely that needs relating to noise and fumes would also be satisfied.

4. We are considering, of course, the kind of street which lies within an environmental area, and where, in consequence, the general premise must be that the pedestrian has a large measure of freedom, including the freedom to cross the road whenever and wherever he pleases. This amounts to a further definition of a residential access road, for if the canalised or controlled crossing of pedestrians is required, then the presumption is that the road is no longer strictly an access road.

5. In effect this approach amounts to defining the acceptable level of risk for the act of crossing the road. Conditions vary so enormously that it is not possible, by studying accident statistics, to say simply that a street of this or that width, carrying this or that amount of traffic, is safe or unsafe. But there is the possibility that the level of risk might be measured by the *delay* to which a pedestrian is subjected when he desires to cross the road. A person only delays making his crossing if, in his judgement, he might be hit by an approaching vehicle. It is a reasonable assumption that the longer he is delayed the more he is likely to 'take chances' and so reduce his margin of safety.

6. The delay the pedestrian suffers is occasioned of course by his having to wait for a gap in the traffic. The unimpeded movement of vehicles past a point corresponds closely to a random series of events, and the occurrence of suitable gaps can be established by probability theory. The *average* delay for pedestrians (i.e. for those who are delayed as well as those who are not) will depend first upon the volume of traffic (the greater the volume the



1 These two graphs show the relationship between traffic volume, average delay to all pedestrians and the proportion of all pedestrians delayed. The dotted line picks out the case referred to in paragraph 7.

greater the delay), and secondly upon the width of the road (the wider the road the longer it takes to cross and hence a longer gap is required between successive vehicles). These variables can be expressed graphically. The right hand side of Fig. 1 shows the relationship between traffic flows on carriageways of various widths and the average delays to all crossing pedestrians. The left hand side of the diagram shows the relationship between the average delay to all pedestrians and the proportion of the *total* pedestrians who actually do experience delay.

7. It will be noted from the left hand side of this diagram that when 50% of pedestrians are liable to experience delay the average delay to *all* is about two seconds. The corresponding average delay to those who are actually delayed would in this case amount to 4 seconds. It is generally considered that, at about this point, the pedestrian's freedom to cross the road anywhere he pleases in accordance with his own judgement needs to be curtailed, and that canalisation of pedestrians onto some kind of controlled crossing is required. We think that an average delay to all crossing pedestrians of two seconds may be taken as a very rough guide to the border-line between acceptable and unacceptable conditions. Any greater delay would imply that most people (more than 50%) would have to adapt their movements, to give way to motor vehicles—a situation clearly not compatible with the idea of an environmental area. It will be seen that in relation to a 22 ft. carriageway the borderline traffic flow (or, in other words, the environmental capacity) is about 250 p.c.u. per hour. It will also be seen that in relation to, say, a 30 ft. carriagewav the environmental capacity is about 130 p.c.u. per hour, and thus the unexpected fact emerges that *the narrower carriageway will enable more traffic to pass for the same level of risk to pedestrians.*

8. This is, at best, a very approximate definition of the environmental capacity. In practice much would depend upon the *kind* of pedestrians involved in the act of crossing the road. Thus young children and old people are more vulnerable than others, largely through sheer heedlessness, and if these constituted a large part of the pedestrian movement, then the border-line would need to be adjusted to a lower volume of traffic. A refinement of the definition of environmental capacity may therefore be obtained by classifying streets according to the vulnerability of the pedestrians who cross at any specified period of the day. For our investigation we defined three categories: (i) streets with over 50% of particularly vulnerable pedestrians (old and young, mothers with prams, etc.), (ii) streets with 20% to 50% of vulnerable pedestrians, and (iii) streets with less than 20%.

9. The definition of environmental capacity would also depend in practice upon the physical conditions and layout of the street concerned. Some streets would offer a better *level of protection* than others by reason perhaps of better visibility for drivers, fewer parked cars, fewer side entrances, better continuity of footpaths, safer pedestrian access to dwellings, etc. For this purpose streets can be classified into three groups according to whether they offer *high*, *medium* or *low* levels of protection. In the Table which appears later in this Appendix we refer to these as Types A, B and C respectively.

10. Although we have so far confined this analysis strictly to the pedestrian who seeks to cross the road, in practice the definition of environmental capacity would also be bound to depend on the *general* level of pedestrian activity in the street, especially on the numbers of children.

11. Thus there are three main refinements to be applied to the crude definition of environmental capacity—the vulnerability of crossing pedestrians, the physical conditions, and the general level of pedestrian activity. In order to explore the practical effect of these variables we studied some 50 actual examples of residential streets with traffic flows varying from 10 to 1500 p.c.u. per hour. We were able to distinguish immediately the cases where conditions were obviously acceptable or unacceptable (the latter generally being cases where noise or severance by traffic were so great that no consideration of other factors was needed) but we were left with a residue of marginal cases. In order to sort out these marginal cases we applied a 'scoring' system somewhat similar to that employed in the cost-benefit analysis described in Appendix 2. We then calculated the theoretical proportion of crossing pedestrians who would be delayed by the traffic in each particular case, and classified each street into the three classes of 'vulnerability' (para. 8 above) and into the three classes of 'level of protection' (para. 9 above). Then, for the nine possible combinations of 'vulnerability' and 'level of protection' we reached a judgement as to the proportion of pedestrians for whom delay in crossing appeared to be acceptable. The results of this are shown in Table 1.

Table 1: Maximum percentage of pedestrians for whom delay is acceptable in crossing various types of residential access streets.

Level of Vulnerability	Level of protection		
	Type A (High)	Type B (Medium)	Type C (Low)
Low	70	60	50
Medium	60	50	40
High	40	30	20

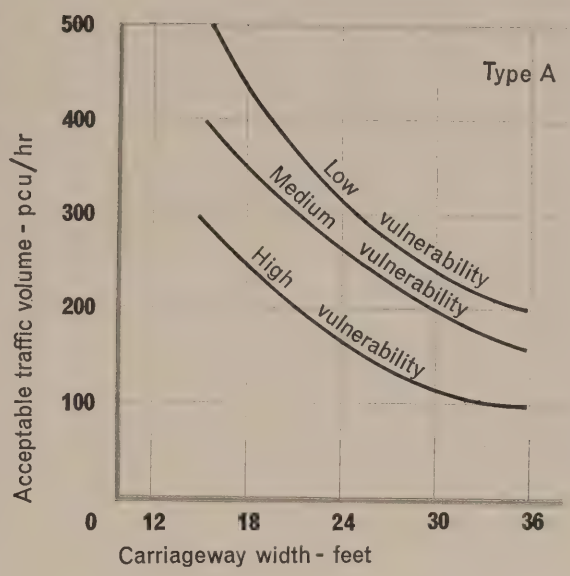
12. With the aid of this table and the relationships shown in Figure 1, we were then able to draw a further series of curves (Figure 2) which enable the environmental capacity to be determined for any width of carriageway and for any levels of 'vulnerability' and 'protection'.

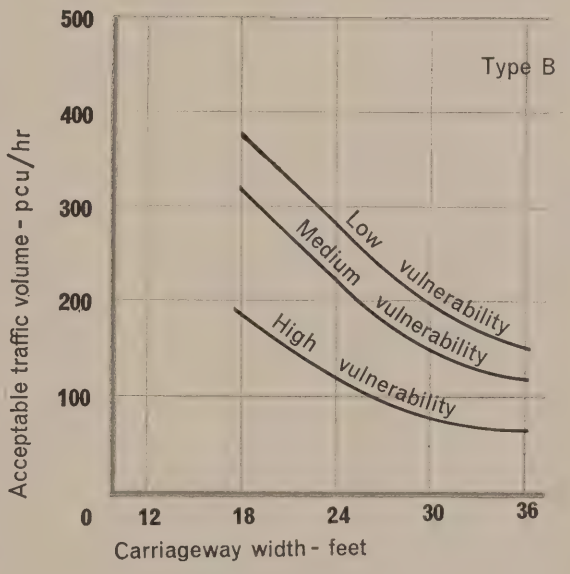
13. To illustrate the practical use of graphs of this kind we may examine the actual case of a street in north London. The street in question has a carriageway 30 ft. wide, with narrow pavements. The lateral development comprises medium density (100 persons per acre) 3-storey terrace houses in multi-household occupation. In addition there are some local shops, a public house, a doctor's surgery and a group of industrial premises at one end of the street. The houses have small fore-courts (4-ft. deep), mostly unfenced, so that there is direct access onto the narrow footways. There are no private gardens, nor are there any parks or children's play areas close at hand. In the morning, in term time, the street is traversed by many children going to school. In the evening there are many children at play. At all times, but especially in the morning and evening there is a great deal of general pedestrian activity, and much random crossing of the road. The street can, without difficulty, be classified as having a high level of vulnerability and a low level of protection (Type C.).

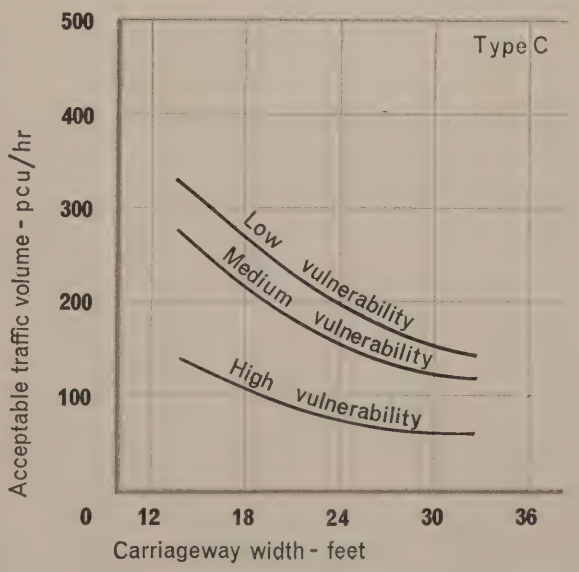
14. It happens that this street forms a link between two busy main routes and it is much traversed by drivers who seek to avoid the congested conditions on those roads. Much of this through traffic consists of persons driving to or from work in the inner areas of London, and the incidence of this traffic coincides with the peak of pedestrian activity. There is also the normal traffic of the street, and the traffic generated by the industrial uses. At the evening peak on a normal weekday the traffic is of the order of 500 p.c.u. per hour, 80% of which is through traffic and 11% heavy traffic. The speed is in the range of 20–25 m.p.h.

15. From Figure 2 it can be seen that, for a street of high vulnerability and low protection, the environmental capacity is little more than 50 *p.c.u. per hour*. This can be compared with the present peak hour flow of 500 p.c.u. We think, for all the crudeness of the method, that this example illustrates the great advantage of making an attempt to quantify these matters and to introduce performance standards. Virtually no yardstick has existed previously, but as a result of the assessments outlined here we feel some confidence in saying that the street in question is carrying *ten times* the amount of traffic that it should carry at the peak hour if tolerable conditions are to be secured for the people who live in it.

2 These graphs show how the acceptable traffic volume varies with carriageway width and degree of vulnerability for layout types A, B and C, described in paragraph 11.







16. If the through traffic could be removed entirely from the street, the peak hour flow would be about 100 p.c.u. which is still higher than the environmental capacity. But it can be seen from Figure 2 that if the carriageway width were *reduced* to 18 ft. the acceptable flow could rise to 120 p.c.u. per hour without affecting the delay to pedestrians trying to cross. The wide pavements that would result would greatly improve the environment of the street, though doubtless in practice some space would have to be allocated for grouped lay-bys for parking.

17. Another method of increasing the environmental capacity would be by reducing the vulnerability level of the street. The main way in which this could be done, short of redevelopment, would be by providing off-street play areas for children. We think this would form an important component of the technique of environmental management outlined previously in the Leeds study.

18. We mention finally one clear impression we obtained from the cases we studied—that in residential access streets vehicle speeds in excess of 20 m.p.h. were incompatible with the needs of pedestrians and the environment generally.

Non-residential access streets

19. In the case of non-residential access streets the time at our disposal did not enable us to examine a sufficiently large sample of streets to apply the method used for residential streets, nor even to check whether it was likely to have any applicability. We content ourselves with describing briefly six case studies which we found instructive in the formulation of our ideas and values, and which we hope, by relating traffic flows to specific street conditions, will give some impression, however rough, of the environmental capacity of certain kinds of non-residential streets. In three instances, however, with the co-operation of the Scientific Adviser to the London County Council, we secured sound-level recordings over a 24-hour period, and we were able to compare these with the recommendations in the Report of the Committee on the Problem of Noise (Wilson Report).

West End Lane, Hampstead

20. We examined a 300 yards length of this road where it serves as a long-established local shopping centre in the middle of a high density residential area (Figure 3). There are about 60 shops with service access from the street and about 120 flats over the shops with pedestrian access either from the

3 West End Lane, Hampstead, London.

rear or from side streets. There are also a church, public house, library, petrol filling station, fire station and a public convenience situated on a traffic island. West End Green, a small open space with grass, seats and large trees, gives a pleasant character to the area. The carriageway varies in width from 22 ft. to 30 ft.

21. West End Lane is a Class II road. It provides a through route from Finchley Road and M1 (the London-Birmingham motorway) to the western part of the central area of London. In the length under consideration there are three terminating bus routes and one through route. In addition to the through traffic there is also, of course, all the local traffic associated with the shops, flats and other facilities. Traffic flows seemed not to vary a great deal with the time of the day, being between 1,000 v.p.h. and 1,200 v.p.h. in both directions at the morning peak period, mid morning on a weekday and on Saturday afternoons. The proportion of heavy vehicles varied from about 15% at mid-morning on a weekday to 8% on Saturday afternoons. Bus flows varied between 45 and 60 buses per hour in both directions.

22. There are no parking restrictions in the length of street under consideration, with the result that for most of the day there are vehicles parked continuously along both sides of the road. The presence of these, combined with the through traffic make for congestion and difficulties of movement for much of the day.

23. There is much pedestrian activity throughout the day. The combination, however, of large traffic flows and parked cars makes the street a difficult and dangerous one to cross. The pedestrian crossings are inconveniently placed at each end of the busiest shopping section, which invites people to cross elsewhere in places where, as they step out between parked cars, they cannot be seen by drivers. The Green, which could be a considerable amenity to the shopping area, is difficult of access because of the traffic, and even when it is reached the traffic is a continuous nuisance. The noise from the traffic is considerable, buses and heavy lorries being the worst offenders. The noise is aggravated by the slight gradient at the narrower part of the street to the south.

24. Sound-level recordings were taken over 24 hours at the kerbside near the petrol filling station. The average hourly readings remained relatively constant at between 71 and 73 dBA* from 8 a.m. to 9 p.m., building up to a peak of 76 dBA between 6 and 7 p.m. Levels dropped to their lowest, i.e. 52 dBA, between 4 and 6 a.m. West End Lane is, of course, a residential as well as a shopping street. The Wilson Report suggests 'as a tentative estimate' that for living rooms and bedrooms in dwellings in busy urban areas, a day-time level of 50 dBA and a night-time level of 35 dBA should not be exceeded for more than 10% of the time. Assuming a difference between external and internal noise readings for closed windows of 20 dBA, and assuming sound levels up to the fourth floor would be the same as at ground level, then, *with windows shut*, the 35 dBA level would be achieved only between the hours of 3 a.m. and 6 a.m.

25. We think there can be no doubt that in this street as it stands, with a volume of traffic of the order of 1,000 to 1,200 v.p.h. in both directions, the conditions are unacceptable, though it would be an exaggeration to say the street is unworkable as a shopping and civic centre.

26. The basic difficulty is that West End Lane is used for two incompatible purposes—the passage of traffic and shopping. In this it is, unfortunately, typical of many thousands of shopping centres on radial and other main roads of towns throughout the country. If it is to continue to be used as a shopping street there is no doubt that it should have no vehicles in it at all. This would mean, however, the exclusion of not only the through traffic but of the local vehicles belonging to shoppers, firms, residents, and even of the buses. As far as through traffic is concerned there appears to be no possibility of a compromise. Either West End Lane must be adapted as a distributor road and the shopping centre removed, or the through traffic must be taken right out. To say which would be the better alternative, or where the through traffic should be put, would involve a network study of the kind demonstrated for Leeds in the preceding section but elaborated to the scale of London.

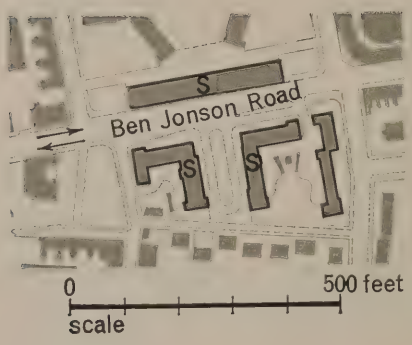
* Decibels (dBA) are a convenient unit for the measurement of sound levels. They incorporate a frequency 'weighting' which compensates, to some extent, for the varying sensitivity of the human ear to sounds of different frequencies.

27. Assuming that through traffic could be removed altogether from the street, we would still be inclined to say that further steps would be necessary to secure a satisfactory balance between accessibility and environment. The provision of rear service access to the shops would be extremely expensive, though it would enable the street itself to be used for pedestrians only. An alternative might be to convert this length of the street into a cul-de-sac or part of a loop system. We estimated that with either arrangement the peak hour flow at the entrance would vary between 70 v.p.h. and 100 v.p.h. according to whether buses were admitted or not. This would enable the carriage-way to be made *narrower* with waiting and loading bays at intervals. We considered that such an arrangement with the much reduced traffic flows would result in satisfactory environmental conditions, and would provide reasonable ease of access for the essential traffic using the street, the residential traffic and the terminating buses.

28. A final point is that it is clear that a fire station and a petrol filling station are unsuitable uses in a street where the needs of pedestrians take precedence. A fire station, to fulfil its functions, needs to have quick access to a distributor road. Once West End Lane ceased to be such a road then it would no longer provide a suitable location for the fire station. The petrol filling station would, of course, attract traffic into the very place where it is not wanted. We think that petrol filling stations should be regarded as 'non-conforming' uses in all shopping streets.

Ben Jonson Road, Stepney

29. This road, lying between Mile End Road and Commercial Road, acts as a local distributor. We studied a section where it also serves as local shopping centre, having been developed for this purpose soon after the war. The lay-out is shown in Figure 4.



4 Ben Jonson Road, Stepney, London.

30. There are some 40 'shops with flats over' in the centre, 14 of these being situated in the cul-de-sac. The carriageway has an average width of 24 ft. All the shops and flats are provided with service access to the rear, and there is in addition some front service space extending along a short section of the frontage on the south side of the road.

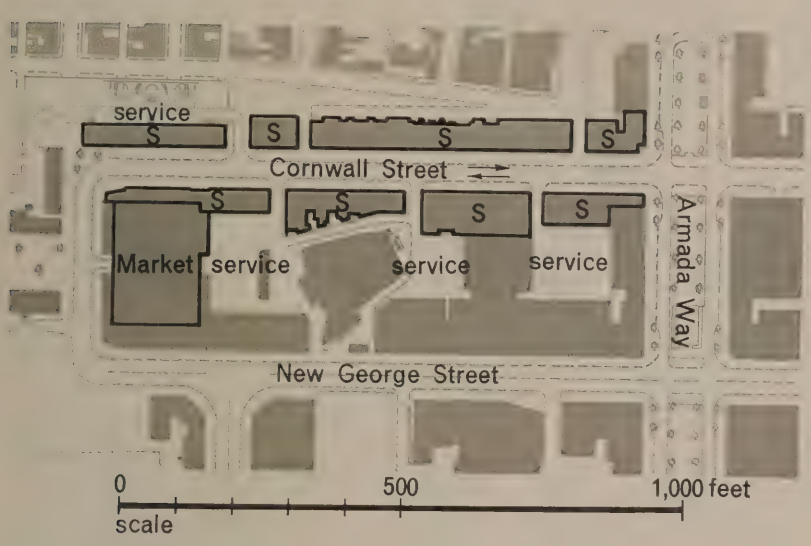
31. We assessed the street for the mid-morning conditions, that is to say outside both the peak periods. The average traffic flow was about 380 p.c.u. per hour, of which 80% was through traffic, and 44% was comprised of commercial vehicles. Pedestrians crossed between the shops (excluding the cul-de-sac) at the rate of about 230 per hour. There are no pedestrian crossings. The bulk of the servicing of shops and flats was taking place at the front of the buildings from the main carriageways, the purpose-provided service areas being apparently used only for refuse collection. Most of the vehicular space in the cul-de-sac appeared to be used for the *garaging* of residents' cars and shopkeepers' vans. There were no parking restrictions in Ben Jonson Road, and parked vehicles caused occasional obstruction and increased the dangers for pedestrians seeking to cross.

32. We concluded that the speed of traffic (25–30 m.p.h.) was clearly incompatible with the requirements of the street either as a shopping centre or as a residential area, and that the volume of traffic was above a tolerable limit, though the conditions were not nearly as bad as in West End Lane. If the through traffic could be eliminated, the residual traffic amounting to about 75 p.c.u. per hour would be acceptable, and there could be several changes in the layout which would assist the centre to function more satisfactorily.

We did not investigate an alternative line for the through traffic but merely drew the lesson that this was a case of comparatively new development where a much better result could have been obtained if only there had existed at the time a closer appreciation of the effects of traffic on shopping conditions, and of the steady growth of traffic itself.

Cornwall Street, Plymouth

33. We were especially interested in this case because it is a central shopping street in one of the major bombed-city reconstructions. We studied the length lying to the west of Armada Way. The carriageway is 30 ft. wide, and the footways 22 ft. each. On the north side of the street there are 46 shops, some with flats and some with office and storage above. On the south are forty shops, including Woolworths, with the retail market behind. There are no street intersections in this length, but there are three entrances to service areas on the south and one on the north. The street pattern is designed to discourage through traffic, which uses a main distributor road to the west of the central area. Traffic is two-way, with unilateral parking, the maximum parking time being 30 minutes in any one hour. There are no pedestrian crossings. (Figure 5)



5 Cornwall Street, Plymouth.

34. At noon on a weekday vehicles were passing (in both directions) at the rate of 700 p.c.u. per hour. About 12% were commercial, and there was a constant movement in and out of the service areas. Some commercial vehicles, however, stopped in Cornwall Street itself to be loaded and unloaded through the front entrances of shops. Parking facilities in the street were fully taken up and there was a constant turn-over of vehicles. Long term parking by those working in shops and offices takes place in the servicing areas. Vehicle speeds ranged up to 25 m.p.h. Pedestrians crossed at the rate of about 2,500 per hour. These crossings were random over the length and do not include any north-south movements along Armada Way. This represents a great deal of pedestrian activity.

35. It can be said of Cornwall Street that accessibility for vehicular traffic is fairly good, though some congestion arises from the reluctance of some drivers of commercial vehicles to use the service areas, and from cars cruising around in the hope of finding a short-term parking space by the kerb. But from the point of view of pedestrians the conditions appear far from satisfactory. The scene is one of confusion for most of the time, with a mixture of moving vehicles and crossing pedestrians. Persons wishing to cross first have to face the hazard of passing through the line of parked vehicles along the kerb, and then they have to dodge the moving traffic. The risks are increased by the occasional vehicle passing along the street at excessive speed.

36. We cannot avoid the conclusion (and it seems to apply to much of the other work in the bombed-city reconstructions) that the design has not, in the event, turned out for the best. Were it possible to start afresh there seems no doubt that much greater regard would be paid to pedestrian movement, and a different kind of design would emerge as a consequence.

Dean Street, Soho

37. We examined a section of this street, 100 yards long, containing specialist shops, offices, a surgery, and two public houses (Figure 6). The street is one-way with parking meters on one side. The carriageway is 18 ft. wide. A busy pedestrian alleyway enters the street on one side, and at mid-afternoon it resulted in a transverse pedestrian flow of about 900 persons per hour. The vehicular flow at this time was about 300 p.c.u. per hour, mainly composed of cars and light vans. There are no pedestrian crossings. There are practically no children using the street and few elderly persons.

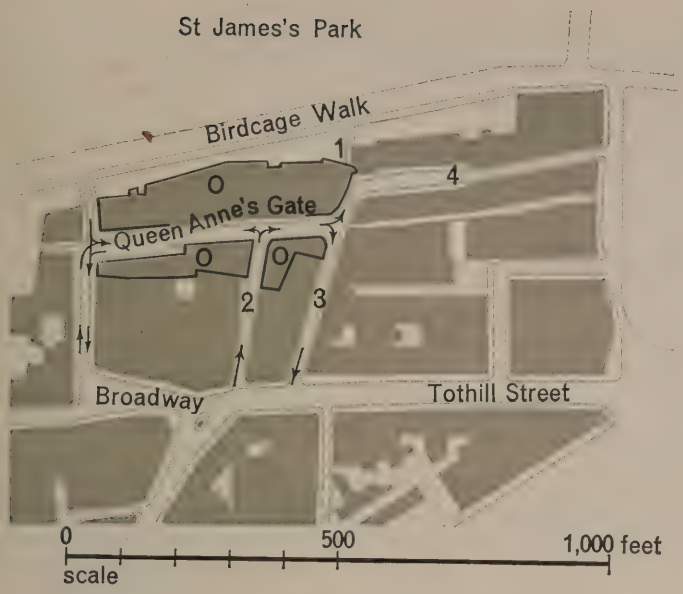
38. Our conclusion in this case was that with a narrow carriageway and one-way traffic, the conditions whilst clearly not ideal, were probably acceptable for an access road within a high density central area.

6 Dean Street, Soho, London.

Queen Anne's Gate, Westminster

39. The layout of Queen Anne's Gate and the adjoining streets is shown in Figures 7 and 8. The part we were particularly concerned with is the section running parallel to St. James' Park. This was originally built as two separate closes separated by a wall which was not removed until near the end of the 19th century. The western part was built around 1704. It is of generous width, about 65 ft. between buildings, and contains fine brick houses. The eastern part was built later in the 18th century. It is narrower and of a somewhat different character, but again has fine houses. The street and the buildings as a whole form a group of outstanding architectural interest. The houses are now used almost entirely as offices.

40. A one-way system operates around these streets as shown on Figure 7. This prevents vehicles from entering Queen Anne's Gate from either Dartmouth Street or Old Queen Street. As a result the main traffic flow is from west to east. The flow in both directions midway along the street is small, being about 80 v.p.h. during the lunch hour and mid-afternoon, and about 110 v.p.h. from 5 to 6 p.m. About 60% of the total daily flow appears to be through traffic in relation to this section of Queen Anne's Gate.



7 Queen Anne's Gate, Westminster, London.

1 Cockpit Steps; 2 Carteret Street;
3 Dartmouth Street; 4 Old Queen Street.

41. There were no parking restrictions at the time of the study and parked vehicles lined both sides of the street totalling some 65 in all. They appeared to be mainly long term parkers—people who work in Queen Anne's Gate and elsewhere. We understand some people park all day in this street, walking across the Park to their work in the Mayfair meter zone. Long term parkers made difficult or prevented the short term parking of delivery and other service vehicles at the kerbside. As a result double-parking took place, which in the narrow part of the street led at times to congestion.

42. The short length of the street and the fairly frequent blockages had the result that vehicles tended to travel slowly, although when the street was clear a few vehicles went through at speed. The traffic flows, however, did not seem to interfere seriously with the freedom of pedestrians to cross the carriageway at will. People even walked *on* the carriageway, perhaps because of the difficulties of getting access to the pavements through the closely-parked vehicles, and perhaps because the pavement is very narrow at the east end of the street on the south side. There is a marked pedestrian route, used at lunch time and at the end of the day, between Old Queen Street and Cockpit Steps and Carteret Street. This is presumably a route to and from St. James's Park Station and the shops, restaurants and pubs of Broadway. People were also walking, in their lunch hour, right along Queen Anne's Gate to and from the park.

43. Sound level recordings were taken over 24 hours at the kerbside in the narrow part of the street. The average hourly readings were between 63 and 64 dBA during a large part of the working day, falling during the afternoon to between 59 and 61 dBA. Our impression of Queen Anne's Gate as a reasonably quiet street for offices appears to be confirmed by the recommendation in the Wilson Report that 55 dBA should be the upper limit to be tolerated in buildings in which communication by speech is of great importance. Assuming a difference between external and internal noise

8 Queen Anne's Gate looking east.

readings of 10 dBA for *open windows*, then sound levels inside rooms in Queen Anne's Gate, with windows open, would not be above 54 dBA. The traffic flow in Queen Anne's Gate is so small (80–100 v.p.h.) that the sound level in the street must derive also from the noise in adjoining streets and areas.

44. The conclusion in this case is plain. It is that the 'failure' of the street is primarily in the impairment of its dignity and character by the presence of vehicles. Parked and double-parked vehicles seem to fill the space between the buildings, the bases of the buildings and the steps and railings cannot be seen, and the relationship between the 'floor' and 'walls' of the street is destroyed. For those people who wish to enjoy Queen Anne's Gate at leisure, the barrier of vehicles inhibits ease of movement about the street and prevents certain aspects from being enjoyed at all. From this point of view there is no doubt that traffic should be reduced to service vehicles and cars and taxis setting down or picking up passengers, and that there should be no through traffic and no long term parking at all.

45. Fundamentally this is a question of values. The street has to be viewed as it is, and the simple question has to be asked whether this is or is not an acceptable treatment for one of the country's outstanding architectural possessions. Our conclusion is that it is not.

Southwark Street, London

46. This is a street which acts as a primary distributor for a busy area south of the Thames. It carries a great deal of traffic. At the peak period (noon) the proportion of commercial traffic is about 56%, and 36% of all vehicles are heavy lorries and buses. The street is to some considerable extent in process of redevelopment as a corridor street of office buildings. We were interested to explore the compatibility between this new function and the existing function of the street as a traffic route, especially from the point of view of the effect of traffic noise on the working conditions in the new buildings.

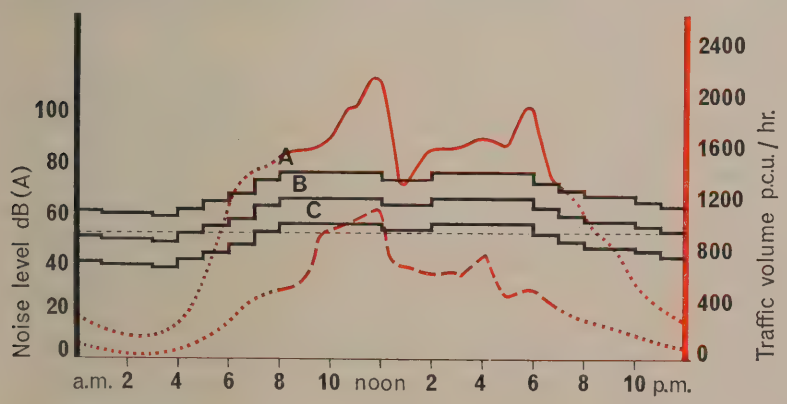
9 Southwark Street, London.

47. We concentrated our study on a large recently completed office block on the north side of the road. The general layout is shown in Figure 9. Sound-level recordings were taken over a 24 hour period inside and outside the building at ground, fourth and ninth floor levels. Simultaneous traffic counts were taken in Southwark Street over ten of the daytime hours. The recordings showed that sound levels are approximately the same at ground and fourth floors, but are lower by about 2dBA at the ninth floor. The difference between external and internal readings was found to be about 17–20 dBA for closed windows and 9–10 dBA for open windows. The average hourly sound level readings for the ground and fourth floors, and the traffic flows are shown graphically in Figure 10.

48. A comparison between traffic volumes and sound levels shows, as might be expected, that the average hourly sound levels are at their highest during the working day when traffic volumes are high and are at their lowest at night when traffic volumes are low. But while traffic flows vary from around 1,500 p.c.u. per hour at 7 a.m. up to 2,200 p.c.u. per hour at noon, and from 1,400 p.c.u. per hour at 1 p.m. to 2,000 p.c.u. per hour at 6 p.m., the average hourly external sound levels remain relatively constant at between 77 and 80 dBA during this period. This suggests that above a traffic flow of around

1,500 p.c.u. per hour, increases and changes in the volume of traffic in Southwark Street do not significantly affect noise levels, but that below this flow traffic volume and noise levels are more directly related. The explanation for this may lie in the reduced speeds associated with the heavier traffic flows. In this connection, however, it is worth drawing attention to a passage on sound level and decibels in Appendix II of the Wilson Report, where it is stated that an increase of three decibels in a sound level meter reading corresponds (roughly) with a doubling of the corresponding sound energy wherever it may occur in the scale. In the case of Southwark Street, although traffic flows increased from 1,500 to 2,200 p.c.u. per hour during the morning, this represents only a 50% increase in sound energy (or source) and therefore only very small variations in the sound level meter readings were to be expected.

49. Inside a ground floor room with the windows partly open, conversation at normal speech levels between people in the room, or on the telephone, was not possible. With the windows closed, sound levels varied between 57 and 60 dBA during the working day. Conversation could be carried on but individual heavy vehicles sometimes made it difficult to hear. Outside the building at ground level it was impossible to carry on a conversation without raising voices at practically any time between 9 a.m. and 6 p.m. The noise of individual heavy vehicles was particularly noticeable. This impression was confirmed by the sound level recordings, which showed that although the average hourly readings for the ground floor and fourth floor were approximately the same, the range of levels recorded was greater for the ground level, going up to 92 dBA as heavy lorries passed. At the fourth floor the extremes of noise were not quite so apparent, the highest external level recorded being 88 dBA. Conditions inside a room on the fourth floor with the windows partly open were the same as on the ground floor. With windows shut conversation could be carried on but individual heavy vehicles were disturbing. At the ninth floor conversation could not be carried on at normal speech levels with the windows open. With the windows shut, when sound levels varied between 55 and 58 dBA during the working day, conditions for normal speech seemed just about acceptable.



10 Noise level in a Southwark Street office block in relation to traffic flow. The dotted horizontal line indicates the maximum noise level 55dBA inside offices as recommended in paragraph 119 of the Wilson Report. Even with the windows closed, this level is continuously exceeded between 8 a.m. and 6 p.m.

Volume of traffic
Volume of trucks and buses only
Estimated volume
Noise level — Ground and fourth floors
A External noise level
B Internal noise level — Windows open
C Internal noise level — Windows closed

50. In the Wilson Report it is suggested that '55 dBA should be the upper limit to be tolerated in buildings in which communication by speech is of great importance'. Offices, of course, come within this category. It can thus be seen that below the ninth floor sub-standard conditions exist in virtually all the rooms facing the street in this very sizeable new office building. The conditions are not marginally sub-standard, but quite seriously deficient. Even at the ninth floor it is only by keeping the windows shut that the suggested acceptable sound level is achieved, but, of course, windows cannot be kept shut in a building which has no air conditioning, especially on a south-facing facade. Figure 10 shows that up to the fourth floor the working conditions are acceptable, even with windows shut, only before 7 a.m. or after 6 p.m.

51. This case obviously gives food for very serious thought. The Wilson Report offers little hope that much can be done to reduce the noise of heavy vehicles, nor does it offer much encouragement on the prospect of improving the insulation of buildings except at the expense of modern methods of cladding. Whilst we ourselves are inclined to be more optimistic on both these points, the general lesson is quite plain that it is to the improved planning and siting of buildings in relation to traffic routes that we must look for the main amelioration of traffic noise.

Appendix 2: Cost-benefit analysis and accessibility and environment

1. In Chapter II, paras. 116–117, the relationship between three variables—environment, accessibility, and cost—was discussed and expressed in the form of a rough and ready 'law': in any environmental area if a certain environmental standard is adhered to, the level of accessibility that can be obtained depends on the amount of money that can be spent on physical alterations. But the relationship is complicated by the fact that some schemes and forms of arrangement are more efficient than others, since for a given expenditure of money, some would result in better standards of environment and/or accessibility than others; or, put in another way, given certain minimum environmental standards, the cost of securing a particular level of accessibility will vary with different forms of arrangement of the roads and buildings.

2. Very little is yet known about which forms of arrangement are the most efficient, either in a general sense, or with reference to particular places or problems such as those examined in the four studies described in Chapter III. A technique is needed to enable the three variables to be measured so that the qualities of different designs can be compared, and so that the most efficient kinds of arrangement—road and parking systems, optimum sizes for environmental areas of different densities and so on—can be identified. The data for this comparison can be supplied by a cost-benefit analysis. This Appendix explains how such an analysis can be applied to test efficiency in the sense just explained, using the three alternative schemes for the redevelopment of Newbury central area as examples.

3. Cost-benefit analysis is a technique which has been devised to assist the making of a rational choice between alternatives, particularly public investment alternatives. The problem of choosing between alternative schemes of public expenditure is not novel to local authorities, for it faces them on every hand. But compared with the private sector, where a promoter can compare schemes in terms of their money costs and returns to him, rational choice in the public sector is difficult, for so often the benefits to be derived are for general use and therefore have no market price. It is primarily to assist such public choice that cost-benefit analysis techniques are being developed.[1] They have been used in this country to test road schemes and a London tube railway extension.[2]

4. Two general points need to be made about the nature of the costs and benefits which are analysed. First, as will emerge in the following paragraphs, these are not the same as in conventional highway cost-benefit analysis. The costs relate to initial construction and exclude maintenance; the benefits are those encompassed in the concepts of accessibility and environment (as discussed in Chapter II), and are expressed as indices, not as money savings in terms of vehicle operating costs, time, and avoidance of accidents. But the costs and benefits *are* similar to those of conventional highway cost-benefit analysis in that only selected aspects are included. If the analysis were made from a comprehensive town planning viewpoint, all conceivable costs and benefits and their effect on all sections of the community would need to be considered.[3]

The role of cost-benefit analysis

5. When considering any scheme to accommodate traffic, an Authority will have in mind certain general objectives. Foremost amongst these is likely to be the establishing of adequate environmental standards and as high a level of accessibility as possible. For any particular town, there could be a wide range of technically acceptable possibilities. But among these will be some which the designers will need to ignore or reject, simply because they would expect them to fall outside the 'constraints' which may limit the Authority's choice. For example, the Authority might be prepared, or allowed by central government, to spend only a certain capital sum on the project, or it might wish to incur only a certain annual expenditure out of its rate resources. In a historic town it might not be prepared to see the demolition of particular buildings or the destruction of a certain character. It might refuse to accept schemes which implied environmental standards below a certain minimum.

6. Within these constraints the designers could prepare a variety of schemes, in which maximum benefits are sought for a given cost, or costs are at a minimum for given benefits. The Authority, if it is to make a rational choice between them, will need to compare the different costs implied in the alternative schemes and the different benefits that will accrue from them[4]. Faced with such an analysis of the estimated costs and benefits for the different projects, the Authority will need some criterion by which to compare them. This should not necessarily point to the scheme with the lowest cost, for that might bring only derisory benefits or result in unacceptable environmental conditions. It should not necessarily select the scheme with the greatest benefits, for these might have to be bought at prohibitive cost. Instead, the criterion should be that pointing to the scheme with the maximum excess of benefits over costs. In order to use this criterion effectively, the costs and benefits should be measured in common, that is money, terms. There is generally

1. See Alan T. Peacock and D. J. Robertson, Ed., *Public Expenditure: Appraisal and Control* (London: Oliver and Boyd, 1963).
2. For the application of the analysis to other kinds of traffic proposals see T. M. Coburn, M. E. Beesley and D. J. Reynolds, *The London-Birmingham Motorway, Traffic and Economics*, Road Research Technical Paper No. 46 (London: HMSO, 1960); D. J. Reynolds, *The Assessment of Priority for Road Improvements*, Road Research Technical Paper No. 48 (London HMSO, 1960); and C. D. Foster and M. E. Beesley 'Estimating the social benefit of constructing an underground railway in London', *Journal of the Royal Statistical Society*, Series A (General), Vol. 126 (1963), p.46.
3. For an attempt see Nathaniel Lichfield, 'Cost-Benefit Analysis in City Planning', *Journal of the American Institute of Planners* (Vol. 26) 1960, p.273; and Lichfield, *Cost-Benefit Analysis in Urban Redevelopment* Research Report 20, Real Estate Research Programme, Institute of Business and Economic Research (University of California, Berkeley, U.S.A., 1962).
4. For a general account see Roland N. McKean, *Efficiency in Government through Systems Analysis* (New York: John Wiley & Sons, Inc. 1958).

little difficulty in measuring costs in money. But while techniques have been devised for placing money values on certain of the benefits derived from traffic proposals[2] they are not yet available for the kind of benefits discussed in the Report. It has been possible, however, to devise a system for giving numerical values to the qualities of the various schemes. Paragraphs 12–26 below, which amplify certain of the concepts embodied in the Report itself, demonstrate that this system relies on: enumerating particular aspects of the scheme; allocating an arbitrary number of points to each and thereby weighting them for importance; and 'measuring' the quality of the scheme under each heading by the subjective allocation of points. Such a points system, it must be admitted, is open to certain objections. For example, the weights and points given to particular aspects must be debateable until enough schemes have been measured in this way to produce a consensus of opinion on them And, furthermore, the system implies that one scheme showing twice the points of another has twice the quality, which may not necessarily be true. But however arbitrary such measurement, until more refined systems of measurement are available, the system is itself more useful than none at all, for it does enable some measure of quality and benefit to be obtained.

7. Under this system of measurement, the amount of benefit can be expressed as an index which can then be compared with the amount of money cost. The resulting ratio gives the 'rate of return'. This enables alternative schemes which produce similar kinds of benefit to be ranked according to their rate of return. The process is demonstrated in paras. 29–34 below.

8. Before proceeding to this, we describe the costs and benefits of three of the Newbury alternatives described in Chapter III, paras. 161–171, and illustrated in Figures 96, 97 and 100. The restricted network scheme (Fig. 100) is referred to here as Scheme A; the minimum redevelopment Scheme (Fig. 96) as Scheme B; and the partial redevelopment Scheme (Fig. 97) is referred to as Scheme C. In each case, our concern is with the central area only, and with only the portion of the primary distributor abutting the east side of the centre, for the rest of the primary is assumed to be common to all the schemes. Each of these three schemes is assumed to be the most efficient, at its own particular level of accessibility and environment; and each is assumed to be achieved over the same time span.

The costs

9. Schemes A, B and C would involve the following works: primary distributor, central area local distributor roads, access and service roads and public pedestrian areas, car parks (both surface-level and multi-storey) the bus station and comprehensive development. All these appear in Scheme C, but in the other two schemes there are no multi-storey car parks or comprehensive redevelopment. It is somewhat unrealistic to assume no redevelopment in Schemes A and B, for clearly there would be some in due course, whether privately or publicly initiated, with consequent cost and benefits. But this is assumed to be sufficiently far removed in these instances to be ignored.

10. Costs for the purpose of this analysis are the net capital costs of preparing the land for building, irrespective of who bears them. This is the capital cost of acquiring, clearing and servicing the land, less the value of any land for building purposes. It includes roads and car parks. The cost of building is excluded.* Table 1 shows the net capital cost on this basis.

11. Table 1 brings out the following points:

(i) Scheme A would cost some £2,680,000. Of this about

* This is because, at the time of development, the cost of the buildings can be assumed to equal their value if cost is taken to include developer's profit, so that their net cost is nil. In other words the net capital cost of a scheme is the same whether the buildings are included or not.

Table 1: Net capital costs of the Newbury town-centre schemes

Work Required		(Restricted Network) Scheme A		(Minimum Redevelopment) Scheme B		(Partial Redevelopment) Scheme C	
		£(000)	£(000)	£(000)	£(000)	£(000)	£(000)
Primary Distributor	Land	230		456		413	
	Works	180		360		360	
			410		816		773
Central Area Local Distributor	Land	1,292		990		1,030	
	Works	116		150		200	
			1,408		1,140		1,230
Car Parks	Land	720		1,180		960	
	Works	120		240		720	
			840		1,420		1,680
Bus Station	Land	30		30		30	
	Works	3		3		3	
			33		33		33
	Less Capital Value of Site	(8)	(8)	(8)	(8)	(8)	(8)
Redevelopment	Land Cost	—	—	—	—	3,530	—
	Clearance	—	—	—	—	52	
							3,582
	Less Capital Value of Site	—	—	—	—	(1,725)	(1,725)
Cost of Land and Works			2,691		3,409		7,298
Less Site Value Redevelopment			(8)		(8)		(1,733)
Total Net Cost £(000)			2,683		3,401		5,565

Notes to Table 1

(i) Since we are concerned with the total costs irrespective of who bears them, the question of grants from central funds can be ignored.
(ii) Costs include professional fees, but no allowance has been made for interest on cost while the works are in process of execution.
(iii) It has been assumed in this Table that the charges for car parks would just cover operating costs, so that no revenue is shown against construction costs.
(iv) For the bus station and comprehensive redevelopment, ground rents are capitalised (at 15 years' purchase) and deducted from initial cost to show net cost of the development; and, as mentioned above, no building costs or values are included.

£400,000 would go on the 'restricted network' road, about £1,400,000 on road works to improve central area circulation and £840,000 on the 2,058 public car parking spaces.

(ii) Scheme B is designed with a higher standard primary distributor road to handle all the traffic expected (at peak hour in 2010), improved internal circulation and more public parking spaces (3,786) at ground level. The additional cost would be £700,000, an extra 27%. Of this, some £400,000 more (a total of £816,000†) would go on the primary distributor road and £680,000 on extra parking spaces, but the internal circulation roads would cost about £270,000 less, largely through saving in land cost.

(iii) The third scheme (C) also has a primary distributor similar to that for Scheme B, still further improved internal circulation, about the same number of public parking spaces (3,639, of which 2,928 would be at ground level and 711 above ground in 4-storey garages) and comprehensive redevelopment to achieve improved layout, environment and accessibility. The capital investment is much greater, about £7,300,000, but net cost would be reduced to £5,560,000 when account is taken of the land values realised on redevelopment. The extra cost of Scheme C over Scheme B is substantial, about £2,100,000. This is accounted for as follows. The primary distributor would cost about the same, the internal circulation an extra £100,000, the parking spaces an extra £250,000. The major increase would arise from the comprehensive redevelopment, which alone would result in a net cost of about £1,800,000.

(iv) Special mention should be made of car park costs. For Schemes A, B, and C these average £425, £380 and £460 respectively per car park space. The increase in Scheme C over Scheme B, for about the same number of car park spaces, is due to the provision in Scheme C of some multi-storey car parks, whose extra construction costs outweigh the saving in land cost.

The benefits

12. The two kinds of benefits which need to be taken into account can be considered under the headings of accessibility and environment. The meaning attached to those terms is broadly that used in Chapters I and II. The method described here enables them first to be considered separately, each in its own right, and then combined into a single 'portmanteau' index of Environmental Accessibility.

13. In the absence of detailed and agreed standards, some very generalised method for measuring the benefits is required—one which is reasonably simple and yet which takes account of the essential features of accessibility and environment. The method described is only one of a number of possible approaches, but it has the merit of providing a rough test which can be applied consistently to the different schemes. Doubtless many improvements would be needed before it could be accepted as a precise measure of the conditions in existing or proposed urban areas.

Crude capacity

14. Vehicles using an area have two initial requirements: they must be able to enter the area from the network of surrounding distributor roads, and they must be able to stop there. The satisfaction of these two needs is largely dependent on the flow capacities of the internal roads and the connections to the network, and on the amount of space provided for parking. *Crude Capacity* is a rough measure of the ability of an area to allow vehicles to enter or leave during a stated period of time and to park within the area. It is defined here as the maximum number of vehicles which (assuming all parking spaces are occupied at the start) can leave the car parks in the area within one hour. The Crude Capacity of an area may thus be limited either by the flow capacity or the parking capacity, whichever is the smaller. Table 2 shows the Crude Capacities for the Newbury town centre as it now exists, and for the three alternative schemes.

Table 2: Crude capacity of the Newbury schemes

	Present layout	Scheme A	Scheme B	Scheme C
Car parking spaces (Public and private)	1,600	2,250	4,000	4,500
Possible discharge capacity of internal roads and connections to network (v.p.h.)	2,200*	1,700	3,500	3,500
Crude Capacity (v.p.h.)	1,600	1,700	3,500	3,500

* This figure represents our estimate of the possible flow out of the centre on the roads as they now exist (including present one-way routes); it takes account of the effect on flow of kerbside parking.

15. Crude Capacity can be used as a tool to enable both accessibility and environmental capacity to be measured, granted sharper definitions of those terms. These are discussed in the following paragraphs.

Accessibility

16. Accessibility can be described as the relationship between the capacity of an area to accommodate vehicles and the number of vehicles seeking to enter and stop within it. Thus in general, the accessibility is equal to the ratio between the 'supply of road space' and the 'demand for road space'. Using Crude Capacity as a measure of the supply, and the potential (peak hour) generation as a measure of the demand,

$$\text{Accessibility} = \frac{\text{Crude Capacity}}{\text{Potential Generation}}$$

17. Every developed area has a certain capacity to accommodate vehicles, and whether vehicles make use of it in small or large numbers, so long as the physical arrangements are fixed, so is the capacity fixed. In contrast, accessibility is a *relative* measure: an area laid out in a certain way in 1930 might have had good accessibility when car ownership was low, but as it or vehicle-usage increases, accessibility would fall, since such increases would imply that fewer of the potential vehicle trips or 'parking acts' could be made in a totally unhindered way.

18. So far, accessibility has been described simply in terms of the capacity of an area and the demand for its use by vehicles. But the accessibility is also conditioned by the *quality* of the layout, and there are four aspects which need to be considered: the safety of the layout for vehicle-use; the distribution of the parking and loading facilities; the suitability of the internal routes to allow vehicles to move directly from one part of the area to another; and the convenience of the layout in other respects for vehicle-users.

19. These four aspects are taken into account in determining the accessibility of the Newbury schemes. The schemes were tested against the following check list. Each aspect has been allotted a maximum possible score according to its possible influence (arbitrarily weighted) on accessibility. The total score (A) for any scheme cannot exceed 100.

† Note: This figure should not be confused with £4½ m. for the whole town distributor system described in Chapter III, para. 173.

Check-list for adequacy of the layout for vehicle-use (A)

Item	Aspects taken into account (Broad Performance Standards)	Maximum possible score
Safety	1. No conflicts between vehicles at links to network or on internal roads	20
	2. No avoidable vehicular conflicts at stopping places or at places where motorists become pedestrians (e.g. at car parks)	20
		40
Distribution	1. Adequate distribution of the loading, waiting and servicing facilities for essential vehicles	15
	2. Adequate distribution of the car parks	10
		25
Penetration and Directness	1. Adequacy of the road system to allow vehicles to penetrate close to buildings; for essential and optional vehicles	12
	2. Adequacy of the road system to allow vehicles to move directly from one part of the area to another	8
		20
Convenience	1. Adequacy of layout for ease of movement, turning and manoeuvring for essential and optional vehicles (in access roads and from car parks, etc.)	10
	2. Clarity for motorist of the road layout; interest from motorists' eyeview	5
		15
	Maximum possible total score	100

20. On the basis of the foregoing, we have constructed a measure of accessibility:

$$\text{Accessibility index} = \frac{\text{Crude Capacity} \times \text{A}}{\text{Potential generation}}$$

All the Newbury schemes would be subject to the estimated potential peak hour generation (for the year 2010), of 3,000 v.p.h. For purposes of comparison, the present potential generation has been taken as 1,250 v.p.h. Table 3 below shows the (A) scores and the Accessibility Indices of the present layout of Newbury, and Schemes A, B, and C.

Table 3: The accessibility of the Newbury schemes

	Present conditions	With year 2010 potential generation			
		Present layout	Scheme A	Scheme B	Scheme C
Crude Capacity v.p.h.	1,600	1,600	1,700	3,500	3,500
(A) score	54	54	60	68	78
Potential generation (v.p.h.)	1,250	3,000	3,000	3,000	3,000
Accessibility Index	69	29	34	79	91

21. The Table shows that if no changes are made to the present layout, accessibility would fall by the year 2010, to less than half its present value, solely as a result of the additional numbers of potential users. Schemes A, B, and C would result in progressive improvements resulting from increases in Crude Capacity and also in the values of (A). By the year 2010, the accessibility of the restricted network scheme (Scheme A) would, in spite of the construction of the new network, fall to only half its present level, but Scheme C would have an Accessibility Index about 1·3 times the figure for present conditions.

Environment

22. When vehicles are admitted into an area, environmental conditions are altered. Accessibility for vehicle-users may be improved, but the environmental standards lowered. There are many difficulties in assessing the effect of such changes on environment: what aspects to take account of, how to overcome the absence of established methods of measurement and the lack of specific environmental standards. These are questions for which there are as yet no fully satisfactory answers, so that precision and objectivity in assessing environmental conditions are not yet possible.

23. To allow some comparison to be made of the environments of the various Newbury schemes, a second 'check list' has been constructed. It follows the lines, but not the content, of the (A) list used as part of the measure of Accessibility. It takes into account the safety, comfort, convenience, and appearance of an area when considered from the point of view of the people living there, working or walking about. These aspects are allotted maximum possible scores which are weighted on the basis of value judgments—for example, it is assumed that safety is more necessary to the occupants of an area than are any of the other factors included in the list. The maximum possible total score for any area is 100.

Check-list for adequacy of the Environment (E)

Items	Aspects taken into account (Broad Performance Standards)	Maximum possible score
Safety	1. Full separation of pedestrians and vehicles	28
	2. No intrusion of through traffic or traffic of unsuitable character	16
	3. No major conflict points; no excessive speeds	16
		60
Comfort	1. No undue proximity of pedestrian areas or buildings to medium-heavy vehicle flows	7
	2. Ditto to grouped car parks or structures, e.g. garages, overpasses, etc.	5
	3. No overpowering 'scale effect'	3
		15
Convenience	1. No severance of closely linked uses by traffic routes (distributors) or unsuitable traffic flows	5
	2. Adequacy of pedestrian access system within the area and to other areas	5
	3. Adequacy of access to public transport for pedestrians	5
		15
Appearance	1. No dominance of scene by moving or parked vehicles	4
	2. Ditto by structures for vehicles, e.g. garages, overpasses, etc.	4
	3. Ditto by street furniture or traffic management devices	2
		10
	Total possible score	100

24. Both the (A) and the (E) lists consist of broad descriptions of desirable conditions. But in the absence of detailed standards and effective units of measurement, these broad descriptions themselves necessarily lack precision; and the testing of schemes against each item can at present be carried out only on a subjective basis. The values of (E) for the Newbury schemes were assessed on the basis of the above check list. The results are shown in Table 4, which indicates that the environmental score,

as measured by (E), would increase from 38 under present conditions to 79.

25. The (E) score gives no indication of the capacity of an area to admit vehicles without detriment to the environment. For example, two quite differently arranged areas might each have an (E) score of 80, even though one might allow many more vehicles into it than the other. For this reason we have made use of the concept of Environmental Capacity (Chapter II, paras 129-132), and defined it as:

$$\text{Environmental Capacity} = \frac{\text{Crude Capacity} \times \text{E}}{100}.$$

A high figure for Environmental Capacity may be brought about either by a high Crude Capacity or by a high (E) score, or both. Environmental Capacity is intended to indicate the ability of an area to admit vehicles without detriment to the environment. But since there is clearly no simple, linear relationship between safety, noise or convenience and the *number* of vehicles, environmental capacity does not measure the actual number of vehicles that could be accepted into the area. Environmental capacity should therefore be regarded as an index of capacity.

26. Environmental Capacity cannot be used in the above form to compare alternative schemes of different sizes; for that reason it is expressed in Table 4 as a capacity per acre of site. The Table shows a progressive increase in Environmental Capacity per acre of site for Schemes A, B, and C. This increase in capacity is due to the combined effect of the higher Crude Capacities and higher (E) scores for Schemes B and C.

Table 4: The environment of the Newbury schemes

	Present layout	Scheme A	Scheme B	Scheme C
Crude capacity (v.p.h.)	1,600	1,700	3,500	3,500
(E) score	38	64	72	79
Environmental Capacity	610	1,090	2,500	2,760
Total site area (acres)	113	124	132	132
Index of Environmental Capacity (per acre of site)	5·4	8·8	19·2	21·9

27. The quality of the different schemes can now be compared. If reference is made to Tables 3 and 4, the following points emerge:

(i) The fairly high Accessibility for present conditions is partly explained by the good penetration that vehicles can achieve at the expense of environment. It is also explained by the comparatively low level of potential generation at present.

(ii) If no works are carried out, the Environmental Capacity of course remains constant, but Accessibility falls sharply, because of the greater potential traffic generation.

(iii) Scheme A would raise Environmental Capacity to a figure higher than exists at present, but Accessibility would remain below its *present* level.

(iv) Schemes B and C would have considerably higher Environmental Capacities and Accessibility than obtain at present. The C scheme has an Accessibility Index 1·3 times that for present conditions but its Index of Environmental Capacity is about 4 times that for present conditions.

Environmental accessibility

28. The foregoing measures of the accessibility and environment of the different schemes can be expressed as a single index, to facilitate analysis of the costs and the benefits. The Index of Environmental Accessibility is equal to $\frac{\text{Accessibility Index} \times \text{E}}{100}$.

The figures for the Newbury Schemes are shown in Table 5.

Table 5: Environmental Accessibility of the Newbury schemes

	Present conditions	With year 2010 potential generation		
		Present layout	Scheme A	Scheme B	Scheme C
Accessibility Index	69	29	34	79	91
(E) score	38	38	64	72	79
Index of Environmental Accessibility	26	11	22	57	72

Analysis of cost and benefits

29. Having isolated the costs and qualities of the different schemes, it is now possible to compare them, in order to see the difference in benefit that would be obtained from the different degrees of expenditure. The comparison is first made in answer to the question: If the three schemes are considered as alternatives, which would show the greatest value for money? Table 6 summarises the position showing, in addition to the 3 schemes, the 'nil expenditure' situation in 2010 (i.e. if no works are carried out). It is the improvement over conditions which would exist if no works were carried out which is the measure of benefit derived from the expenditure in a particular scheme.

Table 6: Benefits and costs of the 3 schemes compared with situation in 2010 if no works are carried out

Scheme	Env. Acc. Index	Benefit	Cost £m.	Benefit / Cost
'Nil expenditure'	11	—	0	—
A	22	11	2·7	4·1
B	57	46	3·4	13·5
C	72	61	5·6	10·9

30. The Table shows for each scheme the total cost (from Table 1), the total quality as measured by the Index of Environmental Accessibility (from Table 5), and the Benefit, which is expressed as the improvement in the Index compared with the 'nil expenditure' conditions in 2010. In addition, for each scheme the ratio of Benefit to Cost is shown. This ratio represents the scheme's 'rate of return', even though the benefit is measured by an index rather than money value.

31. From the Table it is apparent that on the basis of this criterion alone, the Authority should choose Scheme B, for it has the highest rate of return in terms of environmental accessibility over money cost.

32. But the Authority might then ask a more complex question. Would the additional benefits of Scheme B over A, or C over B

Table 7: Comparison of the incremental costs and benefits of the 3 schemes, in terms of Environmental Accessibility

Scheme	Incremental		
	Benefit	£m Cost	Benefit/Cost
Nil expenditure	—	—	—
A	11	2·7	4
B	35	0·7	50
C	15	2·2	7

justify the additional cost? To answer this, Table 7 shows the incremental (extra) benefits, costs, and benefit-cost ratios of each scheme over the preceding one.

33. The following conclusions emerge from Tables 6 and 7:

(1) Environmental Accessibility rises with total costs throughout, including Scheme C. Each scheme thus produces extra benefit for extra cost, and Scheme C produces the maximum benefit.

(2) Scheme B is clearly worth proceeding to. Both its benefit-cost ratio and incremental benefit-cost ratio are the highest; the extra benefit over Scheme A is comparatively high for the cost involved.

(3) But since the incremental benefit-cost ratio for Scheme C falls sharply, from 50 to 7, there must be some doubt about the value of proceeding beyond Scheme B.

(4) If the Authority were restricted in its capital budget, and therefore wished to obtain only the highest possible return on each investment, it would stop at Scheme B, for this offers the best benefit-cost ratio.

(5) But if investment resources were not so limited, it would be worth proceeding to Scheme C provided the extra benefit was greater in money terms than the extra cost. Since benefits are not put in money terms the analysis offers no conclusion in such cases. It becomes a matter for value judgment by the Authority to determine whether the extra environmental accessibility would justify the extra expenditure of £2·2m.

Conclusion

34. This example has shown how an analysis of costs and benefits might assist an Authority in making a rational choice when faced with the need to decide between three schemes, in which there need to be weighed up the three major variables of cost, accessibility and environment. Since no completely clear-cut decision emerges, and the Authority is left to make a judgment, it might be wondered whether the analysis is really of help. The answer to this lies in recognising that the Authority has to make the decision in any case, and in contrasting its situation if it does so with or without the benefit of the analysis.

35. In brief, without the analysis the Authority would probably know the costs of the schemes but would have no measure of just what they would achieve, so that it could not compare the achievements nor judge the extra benefits it could obtain (in cases where a series of alternative schemes can be regarded as stages of a long term design) by proceeding from one stage to the next, Furthermore, it could not measure just what it would be losing in accessibility if it improved environment, and perhaps would over-value the loss and thereby undervalue the environment.

36. To a large degree, therefore, a decision without the analysis would be somewhat blind. And however immature the analysis technique may be at this stage, its use will lead to surer judgment. And as the technique matures, and experience and data are accumulated, so will rational decisions be assisted in the wise use of public investment resources.

37. The conclusions set out in para. 33 reflect the fact that Newbury is a small town with relatively simple problems, where it is possible to achieve high standards of accessibility and environment without resorting to comprehensive redevelopment. We have not applied the method described in this Appendix to larger towns where our studies have shown that comprehensive redevelopment is essential if standards of accessibility and environment are to be substantially improved.

Appendix 3: Glossary of terms used in the report

Accessibility
The degree of freedom for vehicles to circulate and to penetrate to individual destinations and to stop on arrival. Two kinds of accessibility are distinguished—accessibility within an environmental area, and accessibility between different parts of a town and points beyond.

Access road
A road for giving direct access to the land or premises on either or both its sides.

Assign, assignment
When estimating traffic flows between two localities, and there is a choice of route available, then an *assignment* to the various alternatives must be made. It will be based on journey times, knowledge of preferences, presence of danger-spots and bottlenecks, etc.

By-pass
A road which enables through traffic to avoid a locality through which it would otherwise be obliged to pass.

Commuter
A person who makes a regular daily return journey between two places, usually between home and workplace in morning and evening. (Originally, a season ticket holder who paid a *commuted* sum in lieu of daily tickets).

Comprehensive development (or redevelopment)
The complete development or redevelopment of a sizeable area as a phased operation in accordance with a comprehensive plan for the whole area.

Corridor street
A street as defined below, where the buildings are arranged in continuous rows on both its sides.

Cost-benefit study
A type of study designed to ease the burden of decision between various alternative possible measures involving differing expenditures and differing degrees of benefit.

Crude capacity
The capacity of a street or an area to accommodate moving and stationary vehicles without regard to the need to maintain environmental standards.

Density
In town planning, the number of people or the amount of accommodation per unit area of ground. The density of residential areas is usually expressed in terms of people or rooms per acre, and may be *gross* or *net* according to whether ancillary uses such as school sites and public open space are included. The density of business and commercial areas is usually expressed in terms of *plot ratio* (ratio of total floor space to total plot areas excluding local access roads) or *floor space index* (ratio of total floor space to total area of sites including local access roads).

Desire line, desire line diagram
A desire line is a straight line drawn on a map between two points to indicate a desire for a journey to be made between those points. It does not indicate the actual route of the journey. Desire line *diagrams* are used in practice to summarise the desires for movement between specified zones, lines between identical zones being grouped together so that the composite width of the group of lines is in proportion to the total number of desired movements.

Development
Except where used in this Report in connection with the statutory planning system, development means buildings or the use of land for the erection of buildings. In relation to statutory planning it means (as defined in the 1962 Town and Country Planning Act) the carrying out of building, engineering, mining or other operations in, on, over or under land, or the making of any material change in the use of any buildings or other land.

Development control
The process by which a planning authority exercises its statutory duty to control all development (q.v.) in accordance with the provisions of the development plan. The control is enabled by virtue of the obligation upon all developers to seek planning consent for new development. Applications may be granted, granted with conditions, or refused. Aggrieved applicants may appeal to the Minister of Housing and Local Government.

Development plan
The statutory plan which all local planning authorities were required to prepare under the Town and Country Planning Act, 1947 (as superseded by the Town and Country Planning Act 1962) showing their proposals for the use and development of land for a period of approximately twenty years ahead, and which has to be reviewed at periods not exceeding five years.

Distributor hierarchy
The concept of distributor roads connecting one to another through an orderly sequence of function and importance, as the twigs of a tree connect to the branches, the branches to the limbs, and the limbs to the trunk. In this Report, national, regional, primary, district, and local distributors have been distinguished.

Distributor road
A road for the distribution of vehicles to areas of development, designed for efficient movement, and generally having no direct frontage access.

Distributory network
A continuously interconnected system of distributor roads. A *primary distributory network* is the network required in a town to give access to and between the main areas of development.

District distributor
See *Distributor hierarchy, distributor road.*

Environment
The term is used in two senses in this Report. First, in the normal way with reference to the general comfort, convenience, and aesthetic quality of the physical surroundings for living. Secondly, in a more specialised sense, where the term refers only to those aspects of the environment which are directly or indirectly affected by the presence of vehicles—moving or at rest—in urban areas.

Environmental area
An area having no extraneous traffic, and within which considerations of environment (in the specialised sense, as defined) predominate over the use of vehicles.

Environmental capacity
The capacity of a street or an area to accommodate moving and stationary vehicles having regard to the need to maintain the environmental standards.

Environmental management
A technique suggested in this Report whereby the environment of an area could be protected against the adverse effects of motor traffic by measures designed to prevent the entry of extraneous traffic and to re-organise internal flows so that they are less damaging in their effects. It is visualised as a technique which would be started without, in the early stages at any rate, heavy expenditure on capital works.

Environmental standard
A state of affairs defined as acceptable in relation to any or all of the direct or indirect effects of motor traffic on the environment.

Essential traffic
See *Traffic—essential and optional.*

Extraneous traffic
Traffic which has no reason to be in some particular locality apart from having been directed there, or come there of its own accord because no other route is available, or in response to congested conditions or lack of parking space elsewhere.

Floor space index
See *Density.*

Freeway
The American equivalent of a motorway. Other terms are also used for high-capacity roads, such as *expressway, through-way, limited-access highway,* some of which indicate varying standards of design.

Full car ownership
The state of affairs in any area when the ratio of *cars* to population ceases to show a material annual increase. For Britain as a whole it appears that this situation (known also as *saturation level*) may be reached in about 2010 when the ratio may stand at about 400 cars per 1,000 population.

Full use of cars
The unrestricted use of cars in conditions of full car ownership or saturation level.

Grade separation
A technical term to describe the carrying of one highway over or under another with or without facilities for interchange (q.v.). *Fly-over* and *fly-under* have the same meaning.

Individual transport
The movement of people in small vehicles holding only a very few persons, that is to say cars, taxis, motor cycles, etc.

Interchange
A system of interconnecting roadways in conjunction with grade separation providing for the interchange of traffic between two or more highways on different levels.

Lane
A longitudinal division of a carriageway intended to accommodate a single line of moving vehicles. A 'six-lane highway' would be one with three lanes of traffic in each direction. A *reversible* lane is one which may be used by traffic flowing in different directions at different times and is used to accommodate pronounced tidal flows.

Local distributor
See *Distributor hierarchy, distributor road.*

Motorway, motor road
A road reserved for certain classes of motor traffic only. As used in this country the term also signifies a road with no direct access to property and with grade-separated (i.e. fly-over or fly-under) intersections throughout. The term is thus much in the nature of a *specification* for a high-capacity road. *Urban motorway* is a motorway in an urban area.

New Town
As used in this Report, the term applies to urban development works undertaken under the New Towns Act of 1946.

Optional traffic
See *Traffic—essential and optional.*

Origin and destination survey
A survey for the purpose of ascertaining the origins and destinations of journeys.

Overspill
A term used to indicate the planned removal from an area of people or activities, usually with the object of relieving overcrowding or congestion.

Parking standard
In relation to the provision of parking space in new buildings, the number of parking spaces required to be provided by the developer at the behest of the local authority. Standards are usually expressed in relation to the size of the building or the type of activity carried on.

Passenger-car units (p.c.u.)
This term enables the capacity of a highway, or the volume of a stream of traffic, to be expressed in terms of a single number which is independent of the composition of vehicles in a traffic stream. It allows for the different effect of various types of vehicle by considering them in terms of the equivalent number of passenger cars. In practice the equivalents differ according to the layout of the section of the highway system under consideration, but for general purposes in this Report, the following values, appropriate to urban roads between intersections, have been adopted:

Private cars and light vans	1·0 p.c.u.
Motor cycles	0·75 ,,
Medium and heavy goods-vehicles	2·0 ,,
Buses and coaches	3·0 ,,

Peak hour
Strictly, in respect of any road, the period of one hour's duration in the 24-hour day during which the greatest amount of traffic is carried. In practice, however, there may also be distinguished morning, midday or evening peak hours, whose meaning is clear.

Peak period
In a general sense, a period during the day when there is a pronounced movement of people or vehicles in any one direction or set of directions, over and above the normal level of activity.

Piecemeal development (or redevelopment)
Development which takes place by the building or rebuilding of single buildings on individual sites, as and when the market suggests the operation will be appropriate. Such development can take place according to an overall plan for the area, but the

very fact that each building has to be capable of being constructed separately, places a severe restriction on the variety of architectural form that is possible, and on the extent to which the street system can be reorganised.

Plot ratio
See *Density*.

Precinct
An area reserved for pedestrians, all vehicles being excluded.

Primary distributor
See *Distributor hierarchy*.

Primary distribution network, primary network
See *Distributory network*.

Public transport
The act or the means of conveying people in mass as opposed to conveyance in individual vehicles carrying very few people at a time.

Radburn layout
The term derives from Radburn, New Jersey, where, over the whole of a small settlement, the arrangements for pedestrian and vehicular circulation were planned as physically independent but related systems. The derivatives are endless and the implications enormous, but the term is probably best confined to the particular type of loop and cul-de-sac planning for residential areas used at Radburn itself.

Regional distributor
See *Distributor hierarchy*.

Relief road
A term currently used to indicate a road designed to drain off a proportion of traffic from some other road, thereby relieving the congestion.

Reversible lane
See *Lane*.

Ring road
A term applied to any road which encircles the centre of a town. Ring roads are usually designated as 'inner' (i.e. closely circumscribing the town centre with the object of distributing traffic round the centre and also acting as a town centre by-pass), 'intermediate', or 'outer'.

Saturation level
See *Full car ownership*.

Screen line
An imaginary line drawn across part of a traffic study area, across which the total number of movements of any particular kind are determined in order to:
(i) check the estimated traffic flows across the same line, or
(ii) give an indication of the road space required across that line.

Severance
As used in this Report, the undesirable division of an area of closely-inter-related uses by a road carrying a heavy traffic flow.

Street
A form of layout consisting of a carriageway for vehicles, flanking pavements for pedestrians, and with frontage development with direct access to premises for pedestrians and occasionally for vehicles.

Tangential road
A term currently used to indicate a road with an alignment approximately tangential to an imaginary circle surrounding the centre of a town.

Through traffic
The traffic in any area whose origin and destination both lie outside the area.

Town traffic
The traffic within a town, city or community, which is associated with the life and activities of the place. It includes vehicles which have come into the locality from outside.

Traffic
The term is extended in this Report to include stationary vehicles as well as moving vehicles.

Traffic architecture
A term we have coined to convey the idea of buildings and the circulation systems which immediately serve them being designed together as a single comprehensive process. At high densities of development this approach produces architectural forms with built-in multi-level circulation systems in which the traditional dividing line between roads and architecture disappears.

Traffic—essential and optional
Essential traffic is the business, commercial and industrial traffic which is necessary to service and maintain the life of a community. *Optional traffic* is the traffic arising from the exercise of a choice to use a vehicle for a journey when the option existed either not to make the journey at all or to make it by some other kind of vehicle or form of transport. Bus traffic may be regarded as essential to the extent that buses are essential to carry loads which for various reasons cannot be discharged by individual cars. There is not necessarily always a very clear distinction between the two. Some apparently essential trips may, upon examination, prove less essential than some optional trips. In addition, if the distinction is made between the two at *peak periods*, some commercial trips could be called optional, in that they could be made at some other time of day.

Traffic flow diagram
A diagram to indicate quantitatively the volumes of traffic flowing along a road system during some particular period.

Traffic generation
An activity is said to cause or *generate* traffic when vehicles are used in connection with it. The vehicles may be based at the scene of the activity or they may be regular or occasional visitors. As most activities take place in buildings, it is commonly said that buildings 'generate traffic'.

Traffic generation factor
A factor related to floor space, number of employees or other significant aspect of an activity, enabling the total number of daily journeys to be estimated for any specific example of activity.

Traffic management
The promotion of the more efficient movement of traffic within a given street system by re-arranging the flows, controlling the intersections, and regulating the times and places for parking.

Transportation plan
A suggested new constituent of the statutory development plan to indicate the way in which the future demand for movement will be shared by the various forms of transport available.

Transportation study
A comprehensive study of all the demands for movement in a locality (including the use of origin and destination surveys, home interview surveys, and other investigations) to provide a basis for a co-ordinated planning of transport systems.

Turnover
The average number of times that a parking space or loading bay is used by different vehicles during a period of 24 hours.

Visual intrusion
The accumulation of vehicles, moving or stationary, within a locality, in a manner detrimental to the appearance of the scene. This includes equipment and development associated with the use of vehicles.

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Much use was also made of the many relevant Research Notes (unpublished) prepared by the Road Research Laboratory, and many articles appearing in technical journals.

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